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IMPACT OF TEMPERATURE ON STRUCTURAL, MICROSTRUCTURAL AND DIELECTRIC PROPERTIES OF BISMUTH FERRITE

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Abstract

Single phase bismuth ferrite $BiFeO_3$ (BOF) was prepared by co-precipitation technique at low temperature (85°C). The powder was calcined at 450°C, 550°C and 650°C for 1 hour. XRD analysis confirmed hexagonal phase formation. Crystallite size was estimated from the XRD data that showed an increasing trend with the elevated calcination temperatures. Differential Scanning Calorimetry (DSC) was carried out for phase transformation (α to β), Néel temperature (T_N) and melting point temperatures. The variation in microstructures of the BFO pallets with increasing sintering temperatures were studied by Scanning Electron Microscopy (SEM). Electrical ac measurements were carried out within frequency range of 20Hz to 3MHz in this way dielectric constant ($\acute{\epsilon}$), dielectric loss (tan δ), and ac conductivity (σ_{AC}) were also determined. Magnetic properties of BFO powder were studied by M-H loop by utilizing vibrating sample magnetometer (VSM) and ferroelectric properties were confirmed from P-E loop. Both magnetic and ferroelectric properties were carried out at room temperature.

Keywords: bismuth ferrite; co-precipitation technique; differential scanning calorimetry; magnetic properties.

1. INTRODUCTION

The current technological trend of modern century of science conducts a review not only on the tremendous phenomena associated with the materials but also aspect for their fascinating and wide era of novel applications as well. That is why multiferroics have got most prominent attention due to their capabilities combined in their single phase. Multiferroics are said to be the materials with at least existence of two primary ferroic parameters in single phase [1]. The primary ferroic parameters are ferroelectricity, ferromagnetism, ferroelasticity and ferrotoroidicity. The reason of attraction of the scientific world towards multiferroics is their novel applications in electronic devices and spintronic [2]. Bismuth ferrite is one of the most attributed among these multiferroic materials having the title of "only single-phase material which shows multi-ferroism at and above room temperature" with the Curie temperature (T_c) of 820°C and antiferromagnetism Néel temperature (T_N) of 360°C [3]. It is provided with the facts that 21st century memory devices are going to be modified with such materials, because of their intrinsic collaboration between electric polarization and magnetization, which in accordance with the principle allows the data to be written electrically and then magnetically readable. Apart from this, these material's applications can be found in sensors, optical filters and optoelectronic devices [4, 5]. Photovoltaics [6], photocatalyst [7] and photostriction [8] are the extra features found apart from the above-mentioned applications.

Bismuth ferrite (BFO) is found to have a distorted pseudocubic structure with a perovskite form of ABO_3. Here bismuth is on the A site and iron on B site. Space group of BFO is R3c [9]. Body diagonally aligned two perovskite pseudocubes along [111] direction forms rhombohedral, which unites and result in hexagonal unit cell. Ferroelectricity is due to intrinsic electric polarization, which is produced as a result of antisymmetric nature of BFO caused by the off centre shifting of bismuth cation relative to the oxygen anion.

In this way, the energy of BFO is lowered leading to a displacing bismuth cation relative to Fe-O_6 octahedral [10]. In addition, there is a magnetic spiral spin cycloid of 62 nm resulting in antiferromagnetic ordering [11]. The primary hurdle associated with BFO which is to be faced during synthesis is the formation of impure and unwanted phases, beside this the volatile nature of bismuth at high temperatures is also a major cause responsible for the formation of impurity phases. Leakage current is observed because of oxygen deficient environment due to the reduction of Fe^{3+} to Fe^{2+} ions [12]. Another thermodynamic difficulty with BFO is the narrow area of the phase diagram of Bi_2O_3 and Fe_2O_3, where the usual impurities associated very near with BFO are $Bi_2Fe_4O_9$ and $Bi_{25}FeO_{39}$ [13, 14].

The synthesis technique has a strong impact on the phase purity of BFO, recently Shami and his team [15] synthesized pure BFO phase using diverse precursor bismuth oxide by co-precipitation technique. Yao et al. [16] synthesized BFO by solid state reaction method with a second phase and inspected effect of sintering temperature. Effect of sintering on BFO dopants (W^{6+}, Nb^{5+}, and Ti^{4+}) was investigated by Bernardo et al. [17]. Lanthanum-doped BFO was characterized by Ding et al. [18] above $850°C$.

This short paper describes the effect of temperature on the microstructure and dielectric properties of BFO.

2. EXPERIMENTAL PROCEDURES

Bismuth ferrite (BFO) was prepared by co-precipitation method using analytical grade iron nitrate nanohydrate Fe $(NO_3)_3.9H_2O$ and diverse precursor bismuth oxide Bi_2O_3 as suggested by Shami and his team [15]. Iron nitrate nanohydrate was dissolved in deionized water (S1) to make 0.4 M solution on magnetic stirrer and stirred for 40 minutes and the same molarity solution (S2) of bismuth oxide in nitric acid (68% conc.) was prepared on magnetic stirrer with overnight stirring. Solutions S1 and S2 were then mixed together and stirred for 1 hour to make a homogenous and transparent solution(S3). Both the solutions S1 and S2 were carried out at room temperature. Another 1M solution of sodium hydroxide (NaOH) was prepared on magnetic stirrer as a precipitating agent. The precipitating agent was mixed into solution S3 at room temperature ($30°C$) and stirred for another 1 hour with pH = 11. Then the temperature of the solution was raised to $80±4°C$ for fertilization step to be completed for the next 1 hour. The precipitates thus formed were then washed with deionized water 10 times and then placed in an electric oven for 12 hours to dry at $100°C$. The dried precipitates were then grinded in a pestle and mortar to get fine powder. The as prepared powder was analyzed by XRD and Differential Scanning Calorimetry (DSC). Remaining powder was then calcined at 450, 550 and $650°C/1h$, and then palletized pressing uniaxially with 10MPa into green pallets. For further characterizations, these pallets were sintered at 450, 550 and $650°C/1h$.

3. RESULTS AND DISCUSSION
3.1 Structural Analysis

Structural properties were characterized by XRD, which include phase identification, average crystallite size and crystalline nature of the material.
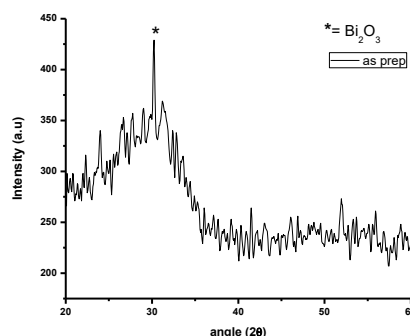
Fig. 1. The XRD pattern of as prepared BFO powder with only one peak of Bi_2O_3.
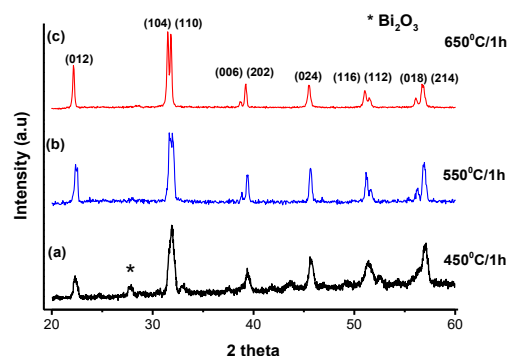
Fig. 2. XRD pattern of BFO powder calcined at (a) $450°C/1h$ (b) $550°C/1h$ and (c) $650°C/1h$.

Fig. 1 shows the XRD pattern of as prepared BFO powder with a peak that appeared at $30°$ belongs to bismuth oxide. While Fig. 2 shows the XRD pattern of the powder calcined at 450, 550 and $650°C$ for 1 hour respectively. All the peaks were labelled and matched with CJCPDS card number 01-072-7678 of $BiFeO_3$ Fig. 2(a) shows the low crystallinity of the powder because at this temperature the material initiates its crystalline nature. Although all peaks were found to belong to BFO except a minor peak found near $28°$ that belongs to the unwanted phase, that is, bismuth oxide (Bi_2O_3) which at high calcination temperature disappeared as shown in Fig. 2(b) and (c). The powder calcined at 550 and $650°C/1h$ show improvement in crystallinity as the temperature increases and disappearance of bismuth oxide peak as it was present in powder calcined at $450°C/1h$. Fig. 2(b) and (c)

confirmed the phase purity of these powder samples calcined at their respective temperatures. There is a splitting as well as shifting behaviour of peaks shown in Fig. 2. The peak at 31.9 degree of $450°C$ sample splits into two peaks (104) and (110) as the calcination temperature is increased from 450 to 550 and then $650°C$. the splitting behaviour confirms the phase transformation from rhombohedral to orthorhombic, whereas the shifting behaviour is possibly due to strain generated in the unit cell, which confirms the increase in d spacing by shifting towards lower 2θ values, this may be due to the oxygen vacancies produced in an oxygen deficient environment and conversion of Fe^{3+} to Fe^{2+} ions occurs in order to maintain the neutrality of the compound, a variation in their ionic radii (Fe^{3+} and Fe^{2+}) causes the strain generation in unit cell. This shifting in a magnified view is shown in Fig. 3.
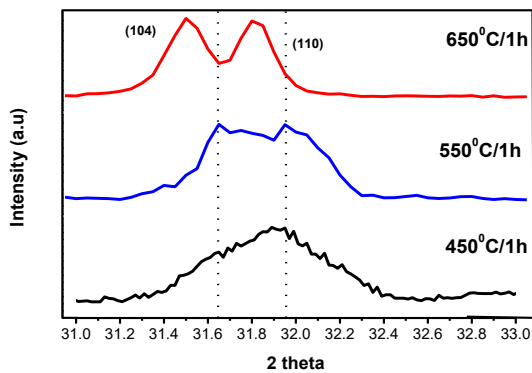
Fig. 3: Magnified view of XRD patterns for 2θ angle [$31°$ to $33°$], showing shifting of peaks (104) and (110) of the BFO powder calcined at $450°C$, $550°C$ and $650°C$ for 1h.

The lattice constants were calculated using standard relation [20] given by 'Eq. (1)' below.

$$\frac{1}{d^2} = \frac{3}{4}\left(\frac{h^2+hk+k^2}{a^2}\right) + \frac{l^2}{c^2} \qquad (1)$$

Lattice parameters 'a' and 'c' were determined using the XRD data by applying check cell software and were found to be 5.58Å and 13.89Å respectively for sample calcined at 550C. These results agreed with the earlier reports [19].

Average crystallite sizes for the major peaks (104) and (110) were calculated by Scherrer's formula [20] given by 'Eq. (2)'.

$$D = \frac{0.9\lambda}{\beta cos\theta} \qquad (2)$$

Where 'D' is the average crystallite size, 'λ' is the X-ray wavelength having a numeric value of 1.5406 Å, 'β' is the full width at half maximum (FWHM) expressed in radian and 'θ' is the angle of diffraction. The average crystallite size was calculated for the two major peaks (104) and (110) for all the three samples. The crystallite size for both peaks were then averaged for all the three samples and found to be 11.3 nm for

the sample calcined at $450°C$, 13.6 and 35.3 nm for the samples calcined at 550 and $650°C$ respectively. So here we noticed an increasing trend of crystallite size with the calcination temperature.

3.2 Thermal analysis

Thermal analysis was performed for the as prepared powder by using high temperature differential Scanning Calorimetry (DSC) from room temperature to high temperature ($1000°C$). The reference crucible was of Al_2O_3. DSC basically figures out the thermal stability, endothermic and exothermic reactions taking place at specified temperatures, structure modification or transformation, crystallization temperature and melting point of the powder. Complete information about the above-mentioned parameters is shown in Fig. 4. If we look upon the entire behaviour of DSC graph, it seems to be a hill like structure showing an exothermic behaviour throughout the temperature range. But, it has majority of endothermic peaks if one studies it in detail. The 1st peak appears within 250-$300°C$ which indicates the Néel temperature (T_N) of $BiFeO_3$, that is, above this temperature the material is no more antiferromagnetic. The two adjacent peaks at 780 and $817°C$ which are magnified and indexed inside the DSC graph, are interpreted as the phase transitions from rhombohedral (α) to orthorhombic (β) [13] and ferroelectric to para-electric, Curie phase transformation respectively [21, 22]. The last intense peak at $959°C$ is assigned to the melting point [23] of $BiFeO_3$ which is in good agreement with the literature [24].
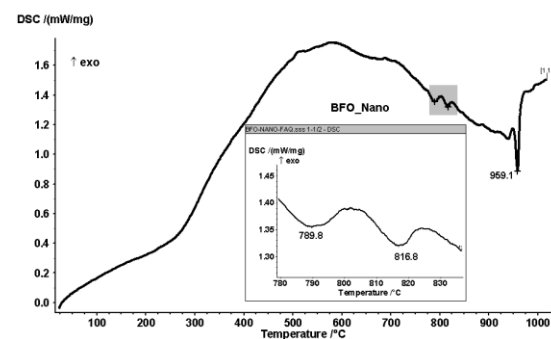
Fig. 4. Differential Scanning Calorimetry (DSC) thermograph of as prepared BFO powder.

3.3 Microstructural analysis

Microstructural analysis of the sintered pallets was performed by SEM, including surface morphology, grain size distribution and particle size. Fig. 5 illustrates the SEM micrographs of the pallets sintered at 450, 550 and $650°C/1h$ respectively. The increasing sintering temperature has its impact on changing morphology of the grains. The porosity is reduced to a

good approximation with densifying pallets also growth in particle size occurred with the increased sintering temperature as shown in Fig. 4. The pallet sintered at 550°C shows more clusters formation and agglomeration than pallet sintered at 450°C, while the pallet sintered at 650°C has a melt like behaviour that may be possibly due to the elevated temperature near the melting point of bismuth ferrite that is about 960°C.
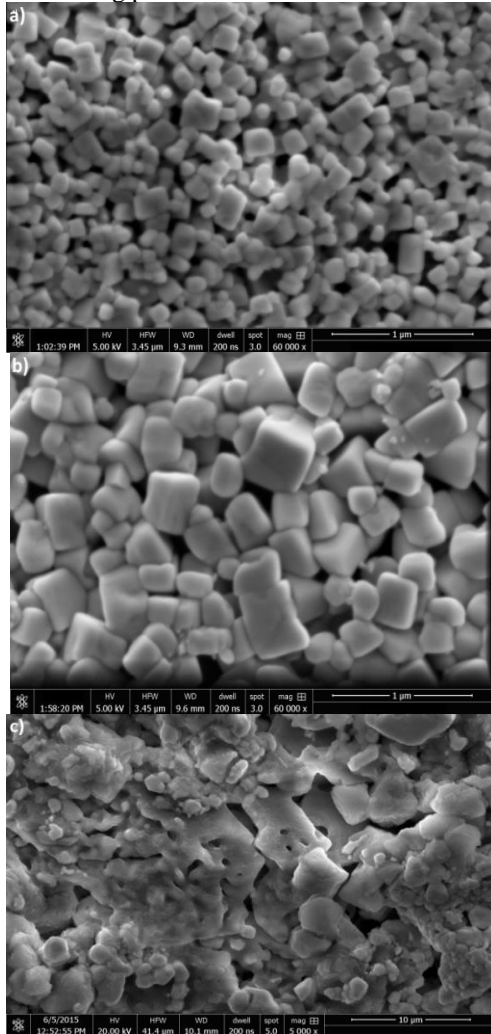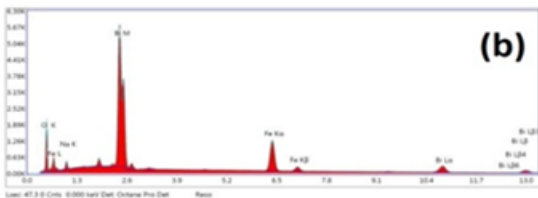
Element	Weight %	Atomic %	Error %
O K	16.72	56.17	9.46
Na K	2.94	6.87	12.73
Bi M	57.24	14.73	2.79
Fe K	23.11	22.24	3.42

The EDX spectrum (Fig. 6) contains the desired elements that are Bi, Fe and oxygen. A minor peak of sodium is present that identifies the presence of sodium that remained inside the final product due to lack of proper care during washing. The EDX results are shown in Table 1.

3.4 Dielectric properties

Dielectric properties including dielectric constant ($\acute{\epsilon}$), dielectric loss (tan δ), were measured using LCR meter within frequency range of 20 Hz to 3MHz at room temperature. Dielectric constant was calculated by using the standard relation [25].

$$\acute{\epsilon} = \frac{Cd}{\epsilon_o A} \qquad (3)$$

Where C is the capacitance, ϵ_0 is the permittivity of free space, d is the thickness of pallet and A is the pallet's cross-sectional area. The dielectric parameters are shown in Fig. 7.The BFO pallet sintered at 550°C/1h possess high dielectric constant than the others, that might be due to highly dense, less porous, more compacted structure and phase pure nature.
The AC conductivity was estimated using the well-known relation. [25]

$$\sigma_{AC} = \omega \epsilon_0 \acute{\epsilon} \tan\delta \qquad (4)$$

Where σ_{AC} is the AC conductivity, ω=2πf is the angular frequency, ϵ_0 and $\acute{\epsilon}$ are defined above. The tanδ is the dielectric loss and it was measured directly from the LCR meter with the frequency range mentioned above. Fig 7 shows the variation of dielectric parameters as a function of frequency. It is evident from the figure that both dielectric loss tangent and dielectric constant show a decreasing trend with increasing frequency. This is because at lower frequencies all the four mechanisms (i) interfacial polarization, (ii) dipolar polarization (iii) ionic polarization and (iv) electronic polarization are responsible for the dielectric properties. They contribute their share as a result, there is a maximum value for dielectric constant at lower frequencies. So, at lower frequencies space charges, electric dipoles, electrons and ions all play their role in dielectric parameters. As the frequency is increased gradually (≈few Hz), space charges undergo relaxation because of not enough time to build up interfacially and their contribution falls.

Fig. 5. SEM images of BFO pallets sintered at (a) 450°C (b) 550°C (c) 650°C.

Fig. 6. EDX result for the sample sintered at 550C

Table 1: Elemental analysis by EDX
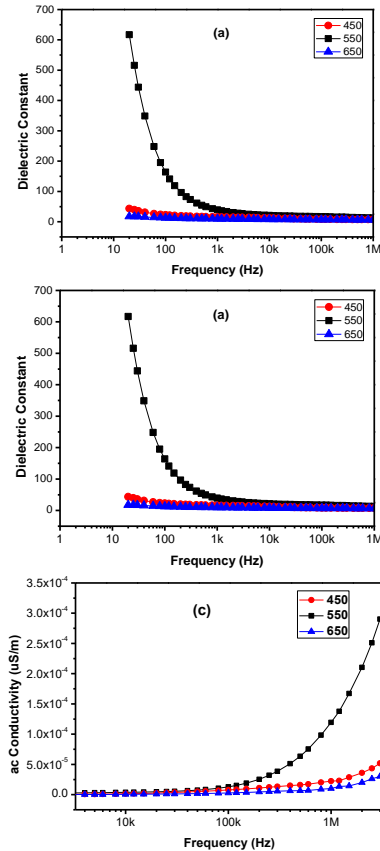
Fig. 7. Electrical AC measurements as a function of frequency from 20Hz to 3MHz for pallets sintered at 450°C, 550°C and 650°C for 1h. (a) Dielectric constant (b) Dielectric loss (c) AC conductivity.

At higher frequencies, the time required for the electric dipoles to align along the electric field direction is not sufficient [26] and thus the contribution of the rest of mechanisms drops as well and at the end there is a minimum value of dielectric constant that is due to the contribution of electrons and ions. While AC conductivity has an increasing trend with that of frequency as is evident from Fig. 7 (c) and Maxwell-Wagner model [27] truly justify it.

3.5 Magnetic measurements

From the microstructural and dielectric analysis, it was noticed that the sample with calcined temperature of 550°C showed more clusters formation and agglomeration compared to other two samples (Fig. 5). The dielectric measurements also confirmed that this sample showed high dielectric constant and high ac conductivity in the reported frequency region (Fig. 7). Therefore, for the magnetic and electric polarization measurement this sample was investigated to save machine time and funds.

The magnetization of BFO sample powder calcined at 550°C is shown in Fig. 8(a), with an applied magnetic field (± 10 kOe). The magnified view of Fig. 8(a) is shown in Fig. 8(b).
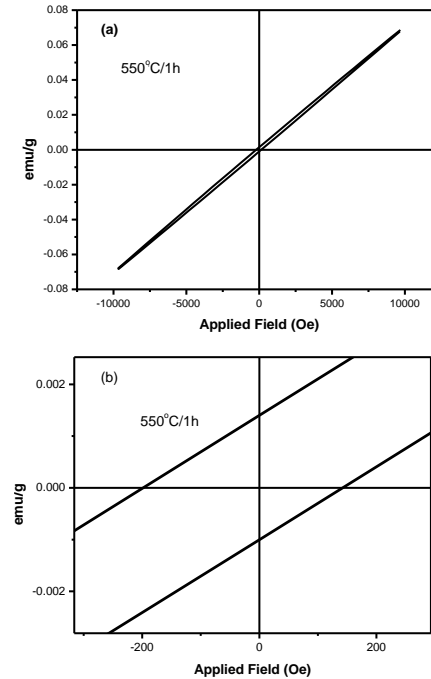
Fig. 8. (a) M-H loop for BFO sample calcined at 550°C with a field strength of ± 10 kOe (b) Magnified view of M-H loop near the origin ± 300 kOe.

BFO is known for its G-type antiferromagnetic behaviour, but, here a weak ferromagnetic behaviour is experienced for BFO powder calcined at 550°C/1h as shown in magnified view of Fig. (8b). This ferromagnetic response of BFO sample is said to be due to reducing particle size, which results an increase in surface to volume ratio, that contributes in interrupting the long range antiferromagnetic order, and thus the uncompensated spins at the surface contributes to total magnetic moments. The spiral spin structure possessed by BFO is thus suppressed partially, leading to a weak ferromagnetic behaviour for nanoparticles [28]. The remnant magnetization (M_r), and coercivity (H_c) were found to be 1.202×10^{-3} emu/g and 170.40Oe respectively, with saturation magnetization of 68.47×10^{-3} emu/g. This enhanced magnetization may be attributed to the produced strain in the structure, which reverts the canting angles and disturbs the cycloid of magnetic moments.

3.6 Electric polarization

Fig. 9 shows the plot of polarization as a function of electric field known as the PE loop reflects the ferroelectric behaviour of $BiFeO_3$ carried out at room

temperature using ferroelectric tester with an electric field range ±80 kV/cm. The PE loop is not completely saturated that may be due to leakage current usually shown by BFO sample because of conductivity at high voltages [29].
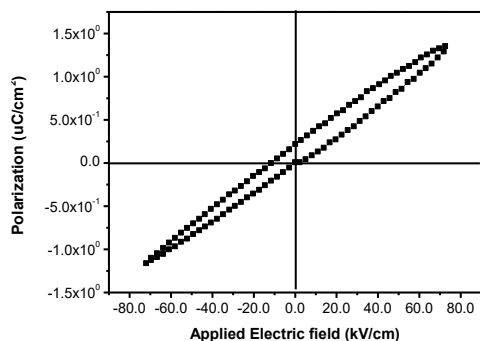
Fig. 9. PE loop measurement for ferroelectric behaviour of pallet sintered at 550°C.

The remnant polarization ($2P_r$) and coercive field ($2E_c$) were deduced from PE loop and found to be approximately equal to $0.44\mu C/cm^2$ and 23.4 kV/cm respectively which is in agreement with the literature [30].

4. CONCLUSIONS

Pure BFO phase has been synthesized by the co-precipitation technique using bismuth oxide (Bi_2O_3) and iron nitrate nanohydrate (Fe (NO_3)$_3$.$9H_2O$). The synthesis temperature was $80\pm4^{\circ}$C, a low temperature [19]. The powder was then calcined at 450°C, 550°C and 650°C for 1 hour. XRD analysis confirmed the perovskite structure of the calcined powder and showed an increasing trend of average crystallite size at elevated temperatures. DSC analysis identified the crystallization temperature (400°C), Curie temperature (816°C) and melting point temperature (969°C) of the as prepared BFO powder. SEM micrographs showed improved microstructures of the sintered pallets, reduced porosity and growth of grain size with increased sintering temperature. AC electrical measurements of the sintered pallets were taken at room temperature. The increasing sintering temperature greatly affected the dielectric properties as a function of frequency of sintered BFO pallets. The maximum dielectric constant and highest AC conductivity was observed for sample sintered at 550°C. This sample was chosen for magnetic and PE loop measurements. VSM data showed a small ferromagnetic behaviour of the BFO powder calcined at 550°C/1h.The PE loop was found to be not fully saturated due to leakage current produced due to oxygen vacancies.

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STRUCTURAL AND CATION DISTRIBUTION IN ZINC DOPED COBALT SOFT NANO FERRITES

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Abstract
Synthesis of $Co_{(1-x)}Zn_xFe_2O_4$ with $0 \leq x \leq 0.6$ by the co-precipitation method is reported along with the structural properties observed by the X-ray diffraction. The variation in the lattice constant, volume of the cell, x-ray density, average crystallite size and the specific surface area were obtained as a function of x. The values of cation distribution in tetrahedral and octahedral bond length d_{Ax} and d_{Bx}, tetrahedral edge, shared and unshared octahedral edges d_{AXE}, d_{BXE} and d_{BXEU} have been estimated, using the observed values of the lattice constant and the oxygen positional parameter for all the samples.

Keywords: X-ray diffraction; Specific surface area; Positional parameter; Tetrahedral bond; Octahedral bond length.

1. INTRODUCTION

Nanotechnology is the understanding and control of matter at dimensions of approximately 1 to 100nm, where unique properties of matter are expected. A ferrite is a type of ceramic compound composed of Fe_2O_3 combined chemically with one or more additional metallic elements. They are both electrically non-conductive and magnetic [1]. Ferrites are divided into two families, hard ferrites and soft ferrites. Hard ferrites have high coercivity; difficult to demagnetize, used to make magnets, for devices, etc. while soft ferrites have low coercivity, easy to demagnetize, are used in the electronics industry such as ferrite cores for inductors transformers and making microwave components[2-6]. The material has high resistivity, prevent eddy currents in the core i.e. reduces energy loss at high frequencies so these are used in the core RF transformer and antennas. The first ferrite compounds were synthesized at the Tokyo Institute of Technology in 1930 for their use in small radios [6]. Soft spinel ferrites having a general formula of A $[B_2]O_4$ where divalent cations like Co^{2+} Mn^{2+}, Cu^{2+} can be substituted in the place of A and the lattice structure is cubic. Further, these soft ferrites can be divided into normal, inverse and mixed depending upon the occupancy of divalent and iron at A- or B-site [2]. In the normal spinel ferrites, the eight divalent metal ions go into the A-sites and sixteen trivalent ions enter the B-site, the structural formula is $M^{2+}[Fe_2^{3+}]O_4^{2-}$. This type of distribution takes place in the zinc ferrite. In inverse spinel ferrites, the divalent ions have a preference on B-site, they will displace eight of trivalent ions which go over into the A-sites. The structural formula of such ferrites is $(Fe^{3+})_A[M^{2+}Fe^{3+}]_B O_4^{2-}$. This type of distribution takes place in the nickel ferrite and cobalt ferrite. In mixed ferrites, the structural formula is $(M_{1-x}^{2+}Fe_x^{3+})_A[M_2^{2+}Fe_{2-x}^{3+}]_B O_4^{2-}$ where x is the degree of inversion and can be controlled by varying in the quenching temperature [5]. Suitable substitution of divalent cation i.e. Co^{2+}, Cu^{2+}, Mn^{2+} in tetrahedral A- or octahedral B-sites can improve their properties significantly. Depending on the chemical composition and cation distribution, these ferrites show a variety of magnetic properties [7-10]. The CoFe2O4 possesses a partly inverse structure and the degree of inversion depends on the method of preparation and the heat treatment [11]. Therefore, Co-Zn mixed ferrite has attracted considerable attention due to the modified and interesting properties of CoFe2O4 and ZnFe2O4. A large number of methods have been developed to prepare Co1-xZnxFe2O4 nano-ferrites, such as the ceramic technique [12], microwave combustion method [13], sol-gel techniques [14], solvothermal [15], the standard solid-state reaction technique [16] and the PEG-assisted hydrothermal method [17]. Further, the magnetic, electrical and dielectric properties of Co-Zn nano ferrites are reported by many workers [7, 17-22]. It has been reported in the literature [19] that the properties of nano-size dimension ferrites and their bulk counterpart are altogether different. Keeping in view the importance of nano-sized ferrites, the Co1-xZnxFe2O4 (0≤ x ≤ 0.6) spinel ferrites are prepared by the co-precipitation method [19]. In the present paper, the physical characterizations of Co-Zn spinel nano ferrite along with the fabrication are discussed.

2. EXPERIMENTAL

$Co_{1-x}Zn_xFe_2O_4$(x = 0.0, 0.1, 0.2, 0.3, 0.4, 0.5 and 0.6) nanoferrites were synthesized via co-precipitation method. The material was characterized by x-ray diffraction.

The structure and crystallite sizes were determined from the x-ray powder diffraction patterns taken from Ref [19] as shown in Fig. 1. The x-ray pattern were recorded at room temperature using CuK_α (λ = 1.5406Å) radiation in 2θ range 20-70° with a scanning rate of 0.02°/min.

3. RESULTS AND DISCUSSION

The structural parameters such as lattice constant, average crystallite size, bond lengths, x-ray density and hopping length were also estimated. The lattice constant (a) was calculated from the standard relation

$$a = d_{(hkl)}\sqrt{h^2 + k^2 + l^2} \qquad (1)$$

Where $d_{(hkl)}$ is the inter planner spacing. The x-ray diffraction line width and crystallite size were calculated using the Scherrer Equation [23]
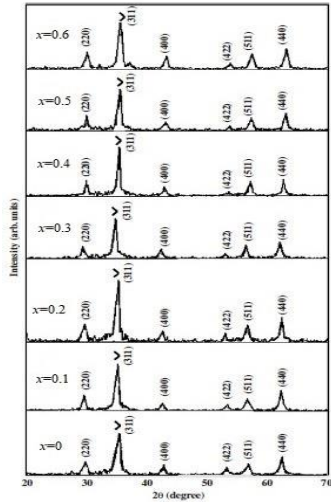
Fig. 1. Indexed X-ray diffraction patterns of $Co_{(1-x)}Zn_xFe_2O_4$ with $0 \leq x \leq 0.6$ after ref. [19]

$$t = \frac{0.9\lambda}{\beta\cos\theta} \qquad (2)$$

Where t is the average diameter of the crystallite, λ is the wavelength of the X-ray radiation, θ is the Bragg's angle, β is full width at half maximum (FWHM) expressed in radian. The x-ray density was calculated using the relation [14]

$$\rho_x = \frac{8M}{Na^3} \qquad (3)$$

Where M is the molecular weight of the samples, N is Avogadro's number and a is the lattice constant. Eight is the number of formula units in a cell. The measured density was obtained using the Equation [19]

$$\rho_m = \frac{m^2}{\pi r^2 h} \qquad (4)$$

Where m is the mass of the pallet, r is the radius and h is the height of the sample, the porosity, P of the nano-ferrites was estimated using the formula [19]

$$P = 1 - \frac{\rho_m}{\rho_x} \qquad (5)$$

The specific surface are ($m^2 g^{-1}$) was estimated from the measured average diameter of the crystallite in nm and the measured density in g cm^{-3} by the formula [24]

$$S = \frac{6000}{t\rho_m} \qquad (6)$$

The bond lengths on the tetrahedral (A) site, the shortest distance between A-site cation and oxygen ion can be calculated. The values of tetrahedral and octahedral bond length d_{AX} and d_{BX}, tetrahedral edge, shared and unshared octahedral edge (d_{AXE}, d_{BXE} and d_{BXEU}) can be calculated by using the experimental values of lattice constant and the oxygen positional parameter, u making use of Standley Equation [25] for ideal spinel ferrites.

$$d_{AX} = \left(u - \frac{1}{4}\right)a\sqrt{3} \text{ (tet. bond)} \qquad (7)$$

$$d_{BX} = a \times \sqrt{\left(3u^2 - \frac{11}{4}u + \frac{43}{64}\right)} \text{ (oct. bond)} \qquad (8)$$

The lattice edge on both tetrahedral (A) and octahedral (B) sites can be calculated from the Equations.

$$d_{AE} = \left(2u - \frac{1}{2}\right)a\sqrt{2} \text{ (tet. edge)} \qquad (9)$$

$$d_{BE} = (1 - 2u)a\sqrt{2} \text{ (Shared octa. Edge)} \qquad (10)$$

$$(d_{BE})_{unshared} = a \times \sqrt{\left(4u^2 - 3u + \frac{11}{16}\right)} \qquad (11)$$

The values of the oxygen positional parameter (u) can be estimated from the expression.

$$r_A = (u - 0.25)a(1.732 - R_0) \qquad (12)$$

Where 'a' is the measured lattice constant and R_0 (1.40Å) is the oxygen ionic radius.

The average cation radii as a function of Co^{2+} concentration of A and B-sites can be calculated using the relations [26]

$$r_A = \left[xr_{Co(A)} + (1-x)r_{Fe(A)}\right] \qquad (13)$$

$$r_B = \frac{1}{2}\left[(1-x)r_{Zn(B)} + (1-x)r_{Fe(B)}\right] \qquad (14)$$

Where r_{Co}, r_{Zn} and r_{Fe} are the radii of Co, Zn and Fe respectively. Ionic radii values used in the calculations are Co (0.74Å), Zn (0.78Å) and Fe^{3+} (A-site 0.49 Å, B-site 0.645 Å) [27]

Hopping lengths of the tetrahedral sites (L_A) and octahedral sites (L_B) have been calculated using the relation [28]

$$L_A = a\sqrt{\frac{3}{4}}; L_B = a\sqrt{\frac{2}{4}} \qquad (15)$$

The x-ray diffraction lattice constants matched with the published patterns [28, 30]. The patterns were analysed following the relations mentioned above. The lattice constant, crystallite size (t_{311}), lattice volume, x-

ray density, measured density; porosity and specific surface area are mentioned in Table 1. The lattice constant increased with the substitution of Zn^{2+} by Co^{2+} because the ionic radii of Zn^{2+} are larger than Co^{2+}. The crystallite size varied from 11nm to 15nm

for this system. It did not follow any specific pattern. The specific surface area increased for smaller nano-crystallite. These observations agreed with the published reports [29]. A summary of the above results is given in Table 1.

Table 1 Lattice constant (a), lattice volume (V), average crystallite size ($t_{(311)}$), X-ray density (ρ_x), measured density (ρ_m), porosity (P) and specific surface area (S) of $Co_{1-x}Zn_xFe_2O_4$ nanoferrites

Parameter	Zn concentration						
	x = 0.0	x = 0.1	x = 0.2	x = 0.3	x = 0.4	x = 0.5	x = 0.6
a (Å)	8.35(1)	8.37(1)	8.37(1)	8.38(2)	8.40(1)	8.42(1)	8.43(1)
V(Å)	581	586	586	591	595	598	601
t(311) (nm)	11	12	15	12	13	12	14
ρ_x (g/cm^3)	5.352	5.348	5.339	5.337	5.313	5.289	5.285
ρ_m (g/cm3)	3.276	3.340	3.443	3.502	3.601	3.630	3.685
P (fraction)	0.386	0.376	0.354	0.341	0.321	0.311	0.303
S (m2/g)	151	136	107	130	117	128	115

Table 2 Cation distribution and related parameters estimated from XRD data for $Co_{1-x}Zn_xFe_2O_4$

(x)	A-Site	B-Site	r_A(Å)	r_B(Å)	u
0	Fe^{3+}_1	$Co^{2+}_1 Fe^{3+}_1$	0.490	0.712	0.381
0.1	$Zn^{2+}_{0.1} Fe^{3+}_{0.9}$	$Co^{2+}_{0.9} Fe^{3+}_{1.1}$	0.529	0.706	0.383
0.2	$Zn^{2+}_{0.2} Fe^{3+}_{0.8}$	$Co^{2+}_{0.8} Fe^{3+}_{1.2}$	0.568	0.699	0.385
0.3	$Zn^{2+}_{0.3} Fe^{3+}_{0.7}$	$Co^{2+}_{0.7} Fe^{3+}_{1.3}$	0.607	0.660	0.388
0.4	$Zn^{2+}_{0.4} Fe^{3+}_{0.6}$	$Co^{2+}_{0.6} Fe^{3+}_{1.4}$	0.646	0.607	0.390
0.5	$Zn^{2+}_{0.5} Fe^{3+}_{0.5}$	$Co^{2+}_{0.5} Fe^{3+}_{1.5}$	0.685	0.562	0.393
0.6	$Zn^{2+}_{0.6} Fe^{3+}_{0.4}$	$Co^{2+}_{0.4} Fe^{3+}_{1.6}$	0.724	0.548	0.393

The variation of hopping lengths L_A and L_B with an increase in the Zn concentration are shown in Table 3. It is evident from the table that hopping lengths L_A and L_B both increase with the increase of Zn content. This behaviour occurs because of the variation of the lattice constant with the Zn contents.

4. CONCLUSION

The samples of Co-Zn spinel nano-ferrites were successfully prepared by the co-precipitation method. The x-ray diffraction patterns confirmed the formation of a cubic spinel structure. The lattice constants are in agreement with most of the authors [32, 28]. The lattice constants increased with the increase of Zn content in the unit cell. The average crystallite sizes and experimental densities varied but agreed within experimental errors. The variation in cation distribution due to the substitution of Zn in cobalt ferrite is calculated and reported.

ACKNOWLEDGEMENTS

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STRUCTURAL AND CONDUCTION BEHAVIOR OF BISMUTH DOPED GADOLINIUM-CERIA ELECTROLYTE

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Abstract

Four samples with composition $Ce_{0.75}Gd_{0.25-x}Bi_xO_{2-\delta}$ (x=0.0, 0.05, 0.10, 0.15) were synthesized to study the structural and conduction properties. The structural analysis through x-ray diffraction (XRD), morphology analysis by scanning electron microscopy (SEM) and electrical measurements including dielectric constant, dielectric loss tangent, AC conductivity and impedance were carried out to characterize these materials for electrolyte applications. An enhancement in electrical conductivity is observed by the doping of bismuth in the samples. Therefore, Gd-Ceria doped with Bismuth appears to be a good candidate for electrolyte applications.

Keywords: Gadolinium; Cerium oxide; Bismuth; electrolyte; conductivity.

1. INTRODUCTION

Fuel cells are renewable energy resources that have no combustion and destructive effects on the environment [1]. Nowadays, researchers are more interested in the preparation of solid oxide fuel cells (SOFCs). The major challenges in this direction are less cost, higher efficiencies, and durability. Solid oxide fuel cells (SOFCs) can work under different temperature ranges, that's why it is more considerable than others [2], [3]. In high-temperature SOFCs, the operating temperature range is ~800-1000˚C. Due to such high temperatures, there are so many issues with large-scale productions like high temperatures generated limitations for the applications of SOFCs which results in chemical and mechanical deficiencies [4]. These issues affect the development and usage of high-temperature solid oxide fuel cells (SOFCs). To overcome the high-temperature issues, scientists developed intermediate temperature solid oxide fuel cells (IT-SOFCs) which may work at the low temperatures of the order ~500-750˚C [5]. Based on recent research, it is found that solid oxide fuel cells (SOFCs) are most favourable for fuel flexibility and high-power densities [6]. The electrolyte is the major and central part of the solid oxide fuel cells (SOFCs) which helps to migrate the oxide ions (O_2) from the cathodic part to the anodic part. These oxide ions then make a reaction with the fuel to produce electricity. It is assumed that electrolyte materials should be less expensive, thermally stable, and thin to reduce ohmic loss [7]–[9].

The rare-earth (RE) metals have vast application in the field of nanotechnologies due to their optical, catalytically, and reduction like properties. The RE metals have been conceived a lot of attention for the last few decades because of their usage in various synthesis techniques and applications like cathode, anode, and electrolyte in SOFCs, etc. [10]–[15]. In the electrolyte of SOFCs, ceria-based materials have been often rapidly used which are industrially most applicable alloy [16]. Doped ceria-based materials with RE metals are compatible electrolytes for intermediate temperature solid oxide fuel cells (IT-SOFCs) in which oxygen vacancies are generated by the addition of trivalent cations that increases conductivity [17]. The major focus is to investigate the source of energy that should be friendly and environmentally clean [18]. Recent research aimed to develop the ceria-based substances as an electrolyte because they have good ionic and electronic conductivities. Gadolinium doped ceria (Gd-ceria) has been studied in the last few decades and showed good outcomes among other substances. Gadolinium doping is widely considered in the case of ceria, whereas multiple

doping is more favourable for an improvement in conductivity [19]–[21].

Accardo et al. [22] synthesized a Gd-ceria sample by sol-gel combustion technique along with prominent electrical properties and investigated that Gd-Ceria with 20 mol% Gd content had superior ionic conductivity. Shih et al. [23] synthesized ceria nano-sized particles and observed that the crystallite size of nanoparticles increased with an increase in calcination temperature. Lenka et al. [24] observed the influence of grain size on conductivity and noticed low conductivities with small grain size at low temperatures while higher conductivities achieved with larger grain size at the higher temperature. Jadhav et al. [25] synthesized the Gd-ceria sample by combustion technique and obtained high conductivity due to the doping of Gadolinium in the ceria electrolyte sample. Anjaneya et al. [26] synthesized the Gd-ceria sample by carbon co-precipitation method and found a decrease in conductivity by doping of Gd content above 20% due to the hindering effect. Priya et al. [27] have studied Gd-Ceria co-doped with Bismuth ions for the reduction in temperature and reported that the conductivity results almost the same but the sintering temperature of Gd-Ceria co-doped with Bismuth ions is 25 % less than that of Gd-ceria. Gil et al. [28] observed that sintering temperature was reduced by the addition of Bismuth in the Gd-ceria sample. Guan et al. [29] investigated Gd-ceria and co-doped Gd-ceria materials, they observed that activation energy decreased by co-doping of Bismuth in Gd-ceria electrolyte material. Dikmen [30] investigated that the conductivities could be enhanced by co-doping in Gd-ceria samples. Raghvendra and Singh [31] observed a decrease in grain boundary resistance as the bismuth (Bi) concentration increased in Gd-Ceria electrolyte. Fu et al. [32] examined that sintering temperature could be reduced by the addition of Bismuth in the Gd-ceria electrolyte. Bismuth doped Gd-Ceria (Bi-GDC) electrolytes gained huge results in conductivity for IT-SOFCs and this improvement in conductivity is due to the growth of grain by bismuth (Bi) doping to attain the materials that have become highly dense [33], [34]. In the literature, different synthesis techniques have been used for the preparation of ceria-based materials. The sol-gel method returns into good ionic and electronic conductivity as reported in ref. [22]. Andrianov [35] observed that oxide materials prepared by the sol-gel technique can reduce the synthesis temperature by 150-200°C. Investigations for Bi-doped Gd-ceria is still required to improve the results. The present study aims to enhance the conductivity of Gd-Ceria and doped Gd-ceria samples by incorporating a WOWS sol-gel method to analyze the conduction and structural properties of the prepared samples. In this technique, no water and surfactants are used as precursors [36]. This method is very effective because of its easiness and the purity level is also enhanced in the final compound. The advantage of this method is that the synthesis temperature is decreased by 150-200°C and can retain the consistency of particle size in the final compound.

2. EXPERIMENTAL

2.1. Synthesis of samples A WOWS sol-gel method was carried out to synthesize the samples namely S-1, S-2, S-3 and S-4 for composition $Ce_{0.75}Gd_{0.25-x}Bi_xO_{2-\delta}$ with x = 0.0, 0.05, 0.10 and 0.15 respectively. The precursors used for the synthesis were Cerium Nitrate hexahydrate (Ce $(NO_3)_2.6H_2O$), Gadolinium Nitrate hexahydrate (Gd $(NO_3)_2.6H_2O$) and Bismuth (99.9% pure) along with Ethylene Glycol as reactants. All precursors were put into a beaker. Then placed it on a hotplate for heat treatment @ 30 min at room temperature, @ 45 min at 77°C, @ for 2 hours at 125°C (gel formed) and then raised temperature up to 180°C to burn the gel. Then put off the sample from a thermal plate for drying. The final product was ground. Then prepared the pellets of about $\sim 12.5\ mm$ diameter and $\sim 2.25\ mm$ as thickness and sintered at 750°C for 5 hours. After that, the structural and electrical properties of the prepared samples have been investigated.

2.2. Material characterization techniques X-Ray Diffraction (XRD) was used to determine the structural properties of the prepared samples. The powder XRD patterns were recorded using Cu-K_α radiation at room temperature. Calculation of lattice constant (*a*) for cubic system is obtained from the relation [37]-[39].

$$a = d\ (h^2 + k^2 + l^2)^{1/2} \quad (1)$$

Where *d* is the inter-planar distance and *h*, *k*, *l* are the Millar indices. To estimate the average crystallite size of the samples, the Scherrer formula was used [40], [41].

$$L_{avg.} = 0.9\lambda\ /\ \beta cos\theta \quad (2)$$

Where L_{avg} represents the average crystallite size, θ is the Bragg's angle and β is the full width at half maxima (radians). Dislocation density and specific surface area (SSA) are estimated using the formula [42].

$$Density_{(dis)} = 1/L_{avg.}^2\ (unit)^{-2} \quad (3)$$

$$SSA = 6000\ /\ (\rho_m\ x\ L_{avg.}) \quad (4)$$

Where ρ_m is the measured density ($\rho_m = m\ /\ \pi r^2 t$ with *m*, *r*, *t* are the mass, radius and thickness respectively of the prepared samples). The surface morphology of the samples was investigated through the SEM technique (JSM 6490L and Philips Model XL 30 FEG operated at up to 30kV). "Wayne Kerr-LCR meter-6440B" was used to measure the AC electrical properties of the prepared samples. Placed the sample (pallet) between two plates (made up of

copper), by making the sense of a parallel plate capacitor that connected with the LCR meter. Analysis of dielectric constant (ε'), dissipation or loss factor ($D = tan\delta$), impedance (Z), capacitance (C), and phase angle (θ) at room temperature having a frequency within the range between 30Hz to 3MHz were recorded. The dielectric constant represented by ε' of the sample is the capability of dielectric material to store the charge and is measured using the relation [43].

$$\varepsilon' = Ct / A\varepsilon_\circ \qquad (5)$$

Where C, t, A and $\varepsilon_\circ$ represents the capacitance, thickness, area and permittivity of free space (accepted value is $\varepsilon_\circ = 8.85 \times 10^{-12}$ F/m) respectively of the samples. The dissipation factor is given as [42].

$$D = tan\delta = \varepsilon'' / \varepsilon' \qquad (6)$$

Here, ε'' is the imaginary part of the dielectric constant. Relation used to measure the AC conductivity is written as [44].

$$\sigma_{ac} = \omega_\circ \varepsilon' \varepsilon_\circ tan\delta \qquad (7)$$

Where $\omega_\circ$ represents the angular frequency ($\omega_\circ = 2\pi f$) and $tan\delta$ is the loss tangent (dissipation factor). Imperfection formation relies on ionic conduction due to thermal excitation, which generates vacancies, and these vacancies help to transfer ions. The presence of homogeneities naturally cause micro or macro conductivity to increase. At higher frequencies, the AC conductivity is accompanied by a power law and at lower frequencies, a stable transition to independent frequency portion occurs. Power law is also called, Jonscher's power law and is stated below [45].

$$\sigma_\omega = \sigma_\circ + A\omega^s \qquad (8)$$

where σ_ω is the total conductivity, $\sigma_\circ$ represents dc conductivity values at lower frequencies, A is the constant (pre-exponential factor), ω is the angular frequency, s is the fractional exponent (slope of frequency-dependent region) and the value of s varies between 0 to 1 [46], [47].

Impedance is the collective effect of the resistance (Z') and the reactance (Z''). The formula used for the calculation of resistance (Z') and reactance (Z'') can be written as [48].

$$Z' = Z \cos\theta \qquad (9)$$

$$Z'' = Z \sin\theta \qquad (10)$$

Where Z is the impedance magnitude and θ is the phase angle. By the impedance plot, bulk resistance (R_b) can be calculated [49] and the relaxation time (τ) can be estimated using the relation as [50].

$$\omega \tau = 1 \qquad (11)$$

3. RESULTS AND DISCUSSION

3.1 **Structural properties** the indexed X-Ray diffraction patterns of all the samples are illustrated in Fig.1. It has been observed that all the prepared samples reflect the cubic structure. The structure was confirmed using JCPDS card # 00-050-0201 with a lattice constant of about 5.42Å. The phase diffractogram achieved is pure single-phase, which indicates that the unreacted dopants in the sample are negligible. It is noticed that the peaks shifted with an increase in Bi concentration, suggesting that Bi-doped Gd-Ceria samples attain the nano-dimensions. The peaks moved to a lower Bragg's angle (2θ) with the increase of Bi concentration in Gd-Ceria as is shown in Fig.2. The lattice constant (a) showed an increasing trend with the increase of Bi concentration. These results agreed with the reported literature [21]. The lattice constants (a), crystallite sizes, measured densities, dislocation densities and specific surface area of all the samples are tabulated in Table 1 by using Eqs (1-4) respectively.
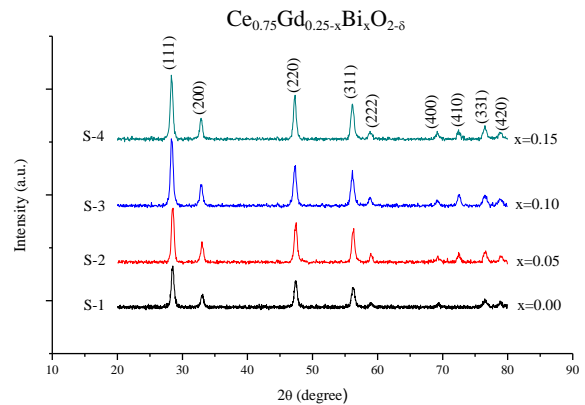
Fig. 1. Indexed XRD patterns of $Ce_{0.75}Gd_{0.25-x}Bi_xO_{2-\delta}$ at room temperature.

The variation in average crystallite size and specific surface area as a function of Bi concentration is shown in Fig.3. The average size of crystallite decreased and specific surface area increased with the increase of Bi concentration, which indicates that bismuth successfully adjusted over Gd-ceria electrolyte materials.
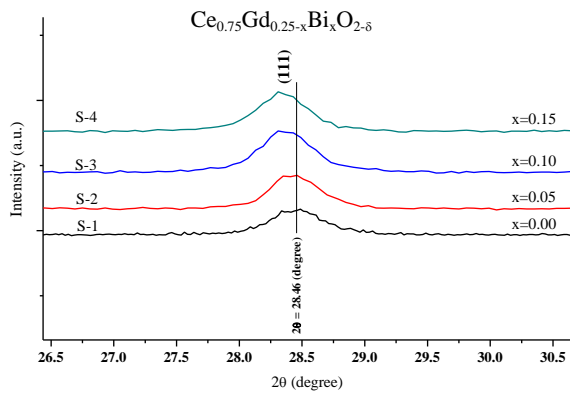
Fig. 2. XRD pattern of $Ce_{0.75}Gd_{0.25-x}Bi_xO_{2-\delta}$ for most intense peak.

3.2 Surface morphology. The surface morphology of the prepared samples investigated through the SEM technique is shown in Fig. 4. The pure Gd-Ceria sample has irregular grains and poor morphology while the Bi-doped Gd-Ceria sample has well-shaped grains and exposed higher densification as is clear from Fig. (4a, 4c) and (4b, 4d) respectively. The particle sizes are in the nanometer range as seen in Fig. 4a and 4b. The crystallite size should be smaller than particle/ grain size, so the results obtained from X-ray diffraction and SEM are in agreement.
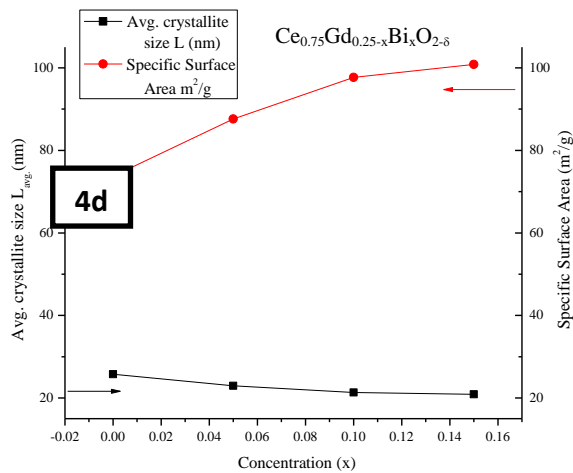
Fig. 3. Variation of avg. crystallite size and specific surface area as a function of Bi concentration.
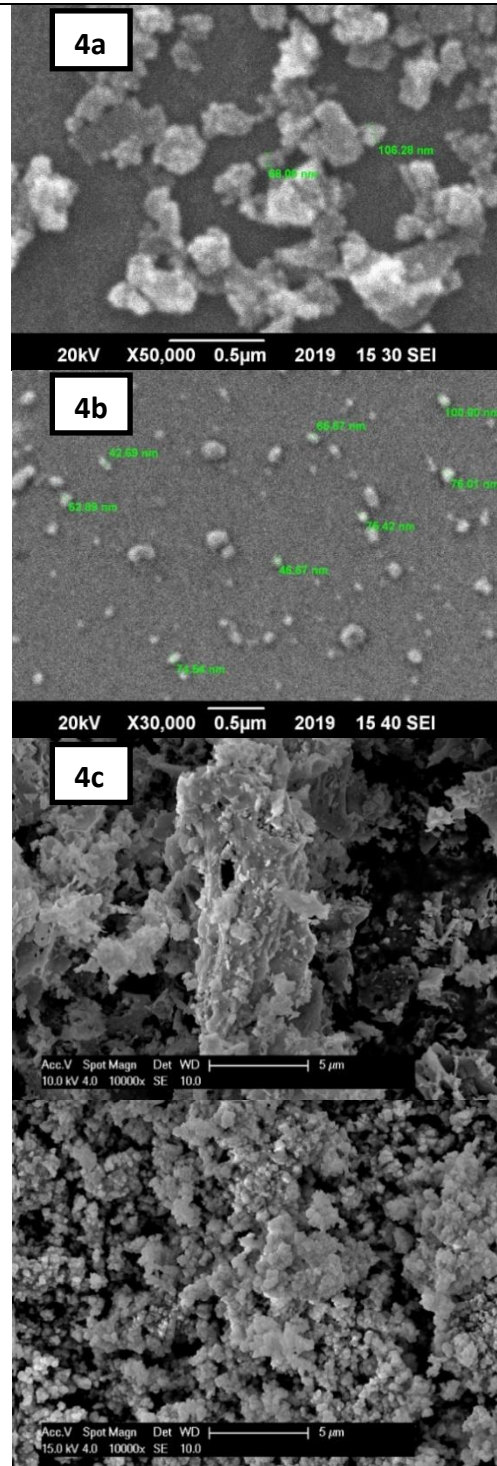
Fig. 4. Surface morphology (SEM) of pure Gd-Ceria sample (4a & 4c) and Bi-doped Gd-Ceria sample (4b & 4d).

3.3 Electrical properties

3.3.1 <u>Dielectric constant:</u> The dielectric constant is divided into two components; one real and the other imaginary (i-e $\varepsilon=\varepsilon'-j\varepsilon''$). The real part of the dielectric constant represents polarization ability and storage power, while the imaginary part of the dielectric constant represents energy dissipation or loss. The real part of dielectric constants for all the samples as a function of frequency at room

temperature are shown in Fig. 5. using Eq.(5). The plot shows the dielectric response and Jonscher's power law is applicable for the materials in which loss peaks are not shown [51]. The higher dielectric constant values at lower frequencies are due to the presence of electrolyte and electrode interference [52]. This plot also describes the polarization phenomenon. Since all forms of polarizations are present in the low-frequency field, the dielectric constant rises. The hopping of electrons between the charges carriers cause polarization at low frequencies. Polarizations disappear as frequency rises, the hopping mechanism lags the applied field, and dielectric constant values drop, causing the material to become un-polarized.

3.3.2 <u>Dissipation factor:</u> Since grain and grain boundaries have high resistances, electrons hopping at lower frequencies required a lot of energy. Crystal flaws and failures can result in losses. Figure 6 represents the graph of the dissipation factor as a function of frequency at room temperature for all the samples. The larger dissipation factor (tanδ) values were observed at lower frequencies. These losses dropped as the frequency increased then these values became frequency independent. This is because there was no ability of dipoles to respond and re-orient themselves with the applied field. The imaginary part of dielectric constants is plotted in Fig. 7 using Eq. (6) that corresponds to the direct measurement of electrical energy losses. Since the hopping behaviour of electrons and the polarization response require a lot of energy, impurities and crystal imperfections lag behind the polarization.

3.3.3 <u>AC conductivity:</u> The AC conductivity plot for all the samples is represented in Fig. 8. The action of the conduction mechanism was described by the jump relaxation model [53]. When ions jump from one unoccupied position to another, conductivity appears at a smaller frequency region. The dispersion mechanism occurs due to the relaxation and the hopping of ions at a higher frequency region. Grain boundaries and the interior ions conduction is confirmed by step in dispersion. Hopping mechanism arises, Jonscher's power law explained this phenomenon. According to this law, ions jump from one position to another position resulting in conductivity. Values of σ_o, A and s obtained from Eq. (8) are tabulated in Table 2. The values of s varying from 0.5 and 1 indicates the meandrous pathway and ideal distant pathways for the ionic conductions respectively [46]. AC conductivities with their higher values confirmed the leading ionic conduction.

3.3.4 <u>Impedance:</u> Impedance analysis is a useful technique for determining the electrical properties of a material. This tool not only provides grain impedance information but also provides grain boundary information. Impedance analysis is often used to figure out the material's real (resistive) and imaginary (reactive) components.
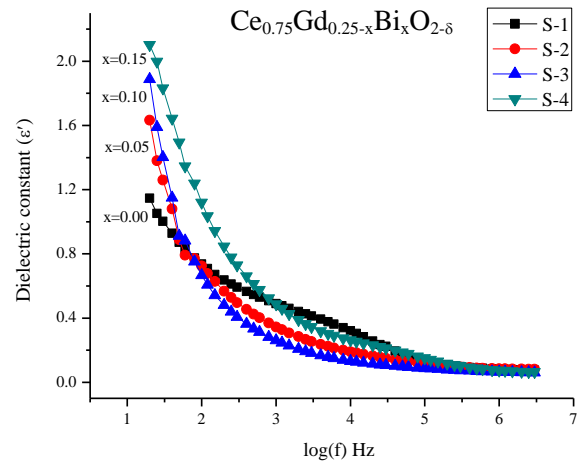
Fig. 5. Variation of dielectric constant (real part) as a function of frequency for $Ce_{0.75}Gd_{0.25-x}Bi_xO_{2-\delta}$ at room temperature.

A graph is shown in Fig. 9. by using Eq.(9) between the real (resistive) impedance component and the frequency of all the compositions. Increased frequency causes a decrease in the real impedance component (Z′) value. Impedance values are very high, at lower frequencies. This is because all forms of polarizations such as ionic polarization, dipole polarization and electronic polarization are present there. As the frequency increased, the real impedance component (Z′) decreased because all types of polarization die out. Another factor for the higher values of the real impedance component (Z′) is the grain boundaries that revealed high resistance to carriers at lower frequencies.
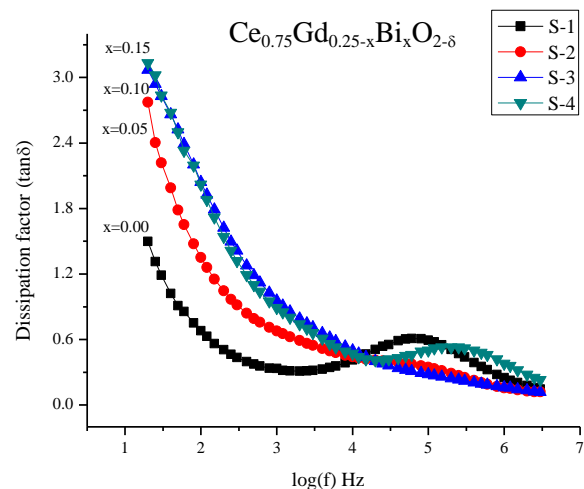
Fig. 6. Variation of dielectric loss as a function of frequency for $Ce_{0.75}Gd_{0.25-x}Bi_xO_{2-\delta}$ at room temperature.
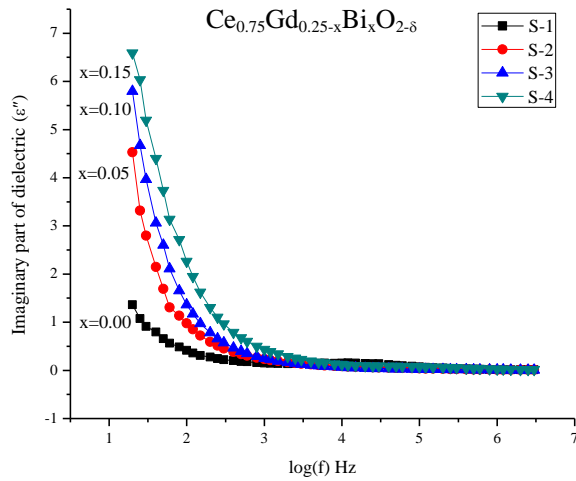
Fig. 7. Variation of imaginary part of dielectric constant as a function of frequency for $Ce_{0.75}Gd_{0.25-x}Bi_xO_{2-\delta}$ at room temperature.

Fig. 8. Variation of ac-conductivity as a function of frequency for $Ce_{0.75}Gd_{0.25-x}Bi_xO_{2-\delta}$ at room temperature.

As the frequency increases, the grain boundaries become conducting. In the current study, the S-4 sample exhibits a much smaller impedance compared to other samples, which is an improvement in conductivity. The imaginary impedance component (Z'') as a function of frequency is shown in Fig. 10. by using Eq.(10). Values of the Imaginary impedance component (Z'') decreased with an increase in frequency and bismuth concentration. The maximum peak corresponds to a process called the relaxation process. The peaks shifted towards lower frequency as the concentration of bismuth increased in Gd-Ceria

electrolyte.

Fig. 9. Variation of real component of impedance as a function of frequency for $Ce_{0.75}Gd_{0.25-x}Bi_xO_{2-\delta}$ at room temperature.

Fig. 11 represents the fitted cole-cole plots that is between the real impedance component (Z') and the imaginary impedance component (Z'') for all the compositions. Semi-circles are observed at higher frequencies, which corresponds to grain bulk properties, whereas grain boundary regions correspond to lower frequency region. The first semicircle shows that resistance R is due to the contribution of grain boundaries and that contribution due to grain is not well resolved. The circuit is shown in Fig.11 with R_s, R_p and CPE representing grain resistances, grain boundary resistances and common phase element respectively. Values of R_s and R_p are tabulated in Table 2. The single semicircle represents strong conductive and dielectric homogeneity. The size of the semicircle represents the magnitude of resistance R [54]. The size of the semicircles decreases as the concentration of bismuth increases, which means that resistance decreases and thus conductivity increases. Relaxation time (τ) and bulk resistance (R_b) have been determined by using Eq.(11) [49, 50], results are listed in Table 2. The values of τ decreased with an increase in Bi concentration. The lower relaxation time to proceed with the reaction would take less energy, which is an advantage of Bi-doped Gd-Ceria electrolyte.

Table 1. Lattice constant (a), crystallite size (L$_{(111)}$), measured density (ρ_m), dislocation density, specific surface area for Ce$_{0.75}$Gd$_{0.25-x}$Bi$_x$O$_{2-\delta}$.

Composition	x = 0.00	x = 0.05	x = 0.10	x = 0.15
Sample no.	S-1	S-2	S-3	S-4
Lattice constant (*a*) (Å)	5.418	5.419	5.422	5.426
Crystallite size L$_{(111)}$ (nm)	20.82	23.86	19.82	19.82
Measured density (ρ_m)	3.16	2.98	2.88	2.85
Dislocation density (m^{-2})	1.51 x10^{15}	1.89 x10^{15}	2.20 x10^{15}	2.29 x10^{15}
Specific Surface Area (SSA) m^{2}g^{-1}	73.72	87.61	97.71	100.81

Table 2. Dielectric constant (ε'), dielectric loss tangent (tanδ), impedance (Z$'$), AC conductivity (σ_{ac}), DC conductivity (σ_o), pre-exponential factor (A), fractional exponent (s), relaxation time (τ), and bulk resistance (R$_b$) for Ce$_{0.75}$Gd$_{0.25-x}$Bi$_x$O$_{2-\delta}$.

Composition	x = 0.00	x = 0.05	x = 0.10	x = 0.15
Sample no.	S-1	S-2	S-3	S-4
ε' at 1 MHz	0.08	0.08	0.07	0.07
ε' at 2 MHz	0.07	0.08	0.06	0.07
ε' at 3 MHz	0.08	0.08	0.06	0.06
tanδ at 1 MHz	0.25	0.15	0.16	0.38
tanδ at 2 MHz	0.18	0.13	0.13	0.28
tanδ at 3 MHz	0.15	0.12	0.12	0.23
Z$'$ at 1 MHz (Ω)	9.56 x 10^3	1.64 x 10^3	6.42 x 10^3	1.43 x 10^4
Z$'$ at 2 MHz (Ω)	3.70 x 10^3	8.04 x 10^2	2.81 x 10^3	6.22 x 10^3
Z$'$ at 3 MHz (Ω)	2.06 x 10^3	5.21 x 10^2	1.72 x 10^3	3.61 x 10^3
σ_{ac} at 1 MHz (S-cm^{-1})	9.27 x 10^{-7}	7.36 x 10^{-7}	5.84 x 10^{-7}	1.57 x 10^{-6}
σ_{ac} at 2 MHz (S-cm^{-1})	1.25 x 10^{-6}	1.15 x 10^{-6}	9.25 x 10^{-7}	2.09 x 10^{-6}
σ_{ac} at 3 MHz (S-cm^{-1})	1.76 x 10^{-6}	1.65 x 10^{-6}	1.21 x 10^{-6}	2.48 x 10^{-6}
σ_o (S-cm^{-1})	1.07 x 10^{-7}	1.93 x 10^{-7}	2.90 x 10^{-7}	6.74 x 10^{-7}
A (S-cm^{-1})	9.78 x 10^{-7}	9.65 x 10^{-7}	9.62 x 10^{-7}	9.06 x 10^{-7}
s	0.62	0.58	0.57	0.52
τ (milli-sec)	7.95	3.18	1.59	1.06
R$_b$ (k-Ω)	53	40	53	34
R$_s$ (k-Ω)	0.00038	0.00085	0.00070	0.00036
R$_p$ (k-Ω)	16.5	9.48	2.15	1.79
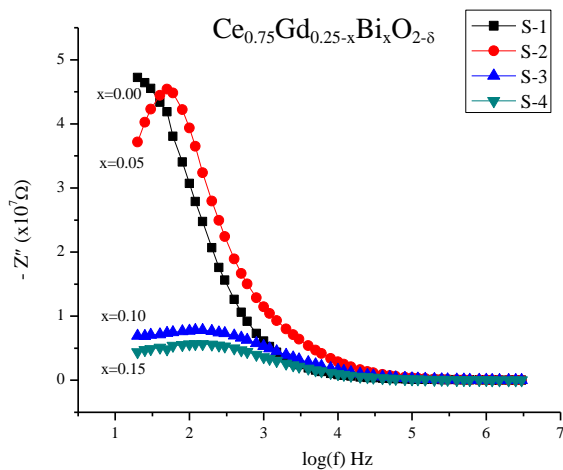
Fig. 10. Variation of imaginary component of impedance as a function of frequency for Ce$_{0.75}$Gd$_{0.25-x}$Bi$_x$O$_{2-\delta}$ at room temperature.
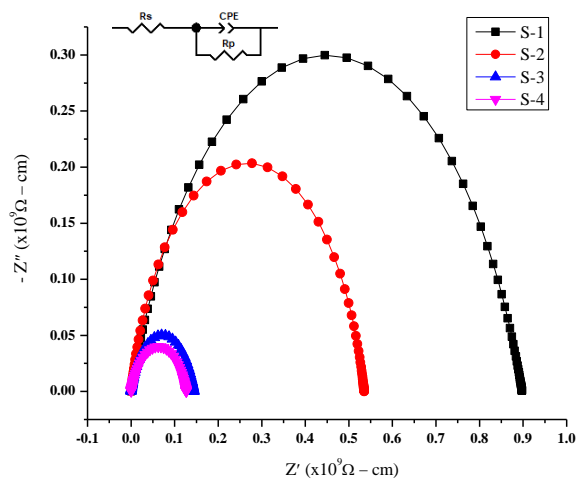
Fig. 11. Variation of fitted Cole-Cole plot as a function of frequency for Ce$_{0.75}$Gd$_{0.25-x}$Bi$_x$O$_{2-\delta}$ at room temperature.

4   CONCLUSION

A WOWS sol-gel technique was used to synthesize all the samples with composition Ce$_{0.75}$Gd$_{0.25-x}$Bi$_x$O$_{2-\delta}$ for x = 0.0, 0.05, 0.10 and 0.15 named as S-1, S-2, S-3 and S-4 respectively to

achieve higher conductivity. The x-ray diffraction scheme was used to acquire the structural information of the samples prepared and then noted that all the samples were single phase with a cubic crystal structure. The lattice constant (a) of all samples is approximately equals to 5.42Å. Peaks moved to lower Braggs angles, as Bi concentration in Gd-Ceria increased. The Average crystallite sizes of all the samples are between 20-26nm. SEM illustrated sample densification with the presence of bismuth. The AC conductivities of all the samples were determined as a function of frequency from 30Hz to 3MHz at room temperature (300 K). Values of relaxation time (τ) and bulk resistance (R_b) were also determined by the Cole-Cole plot. Resistivity decreased with increasing concentration of Bismuth. From the findings, it is observed that conductivity is enhanced by bismuth (Bi) doping in Gd-Ceria materials by WOWS sol-gel method too, which is more beneficial in nanotechnology for solid oxide fuel cells (SOFCs) as a solid electrolyte.

NOMENCLATURE

Capital

L	Average crystallite size
C	Capacitance
A	Area

Lowercase letters

a	lattice constant
d	inter-planar distance

Greek lower case

ω	angular frequency
$tan\delta$	loss factor
τ	relaxation time
ε	dielectric constant

Abbreviations

CPE	common phase element

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ETHNO-POLITICAL CONFLICT IN BALOCHISTAN; THE WAY FORWARD

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Abstract
Balochistan, the largest province of Pakistan with richness in resources has now become a hub of ethno-political conflict. Province is surrounded by conflicting historical background in which two parties the state and Baloch Nationalists are fighting. Baloch Nationalists are of view that their resources are being exploited by state without giving them any proper share. People living in Balochistan suffer a lot because of series of insurgencies. Province faces five major insurgencies with a series of multiple root causes. There are three major group of people living in Balochistan Baloch, Baruhi and Pashtoon. The people of Balochistan province are demanding more political autonomy in provincial affairs while only a minority group is fighting for independence. They are living a life of deprivation far from basic facilities. Balochistan have reservoirs of Gold, Copper and other valuable minerals but unfortunately, they didn't get proper share from it. Majority of residents of province didn't get clean water, education and health facilities which are giving rise to their grievances. The unaddressed Baloch grievances are the root cause of conflict in current scenario. From a historical perspective different government try to address the issue with packages like Aghaz-e-Haqooq-e-Balochistan, 7th NFC award and 18th amendment but the corruption and mismanagement of this sensitive affairs and communication gap among both sides remains the issue at same stage. There are many actors, internal and external involved in conflict with their own objectives. They are using deprived local people to attain their objectives. Conflict in Balochistan have a long history but it can be resolved by addressing the grievances of deprived people of Province and giving them their proper share in provincial affairs.

Keywords: Strategic Significance, Baloch Nationalists, Insurgencies.

1. INTRODUCTION

Balochistan is the strategically significant province, which constitutes about 44% of the total land mass, is Pakistan's biggest province in terms of area. Its location is very important as it borders on two sides internationally which is appropriate for world trade. [1] It is in the countries southwest. It borders on the Arab Sea, Iran and Afghanistan. It is almost half of Pakistan's total territories and 3,6% of its population lives in Pakistan.[2] Balochistan today has been divided among Pakistan, Iran and Afghanistan. The area remains a source of struggle since day of beginning and presently it become a source of Ethno-Political Conflict. A Conflict is characterized as "ethnopolitical" between two or more groups when ethnicity and religion are intensely affected by progressing struggle. [3] Pakistan was detained with ethnicity and regionalism issues after it became independent. While regionalism is not seen as a big problem as a multiethnic society, its robust growth frequently upsets federal system. Balochistan was also a major barrier to the country's greater political integration, being the oldest, most deserted and least populous province in the country. Balochistan province faces five major and many minor insurgencies from 1948, 1958, 1962, 1973 and 2006 since the day of its accession with Pakistan.

The conflict in the province of Balochistan is a constant conflict between the residents of Balochistan and the Pakistani Government based on historical narrative of Baloch people that their resources are being exploited. The Baloch nationalists have always had great demand for regional autonomy and local control of their resources. Since Pakistan was established, this was denied to them. People living in Balochistan have migrated from different parts of world. They are tribal in nature. Currently there are three main tribes Baloch, Baruhvi and Pashtoon. In Balochistan, various nationalist factions fight against the country. These groups battle on the freedom agenda although evidence demonstrates that these groups are supported by international countries. Balochistan conflict needs a political solution in which state uses it full authority and all the state organs play their role whole-heartedly to resolve the conflict on humanitarian bases with least use of force.

2.BACKGROUND OF CONFLICT

It was difficult to map the origin of people living in Balochistan. Historians have associated them with numerous Iranian ethnic institutions. **[4]** With the passage of time these people settled in the region now called Balochistan. The Balochistan region was divided into three other areas during the British rule period: first Kalat, Makran, Kharan, and second Las Bella, third was Tribe Region. It is Pakistan's biggest province. Balochistan has geostrategic significance and huge untapped mineral reserves of oil, coal, gold, copper and others. **[5]** On 27 March 1948, the Kalat State signed with Pakistan the Instrument of Accession. The Conflict in Balochistan began in May 1948.It was led by Sardar Abdul Karim, who was younger brother of Prince on issue of Kalat's accession to Pakistan's newly established Dominion. The Prince waged a guerrilla war with support from Afghanistan Against Pakistan. Following his capture, the insurrection begun by the prince and lost his worth and importance. The dissenters were tactically crushed by the military in the face of this insurgency, which was Pakistan's first ideological and regional frontiers to face. In 1958 the second insurgency started against the merger between Western Pakistan and Balochistan State Union, headed by Nawab Nouruz Khan. However, these requests and grievances were not listened to by the state and key actors. This merger produced in Baloch people a sense of oppression and neglect. **[6]** Nawab and his followers began a guerrilla struggle in 1960. The conflict came to an end with the treason charged Nawab Khan and the death penalty was imposed on his sons and nephews. **[7]** Nawab's death has raised the Baloch people's hate and distrust of the regime.

The third uprising started in 1962. It followed the same phenomenon as the third insurgency. The fourth crisis started in 1972 when Bhutto, on grounds of suspected support of a seceding campaign, smuggling and resistance to modernization, expelled the coalition government in Balochistan. **[8]** The Baloch response to the action was to launch an armed struggle that soon turned into a bloody war with the powerful Pakistan military. Some 80,000 military personnel, including air support from the Air Force, were assigned by the Bhutto government. In July 1977, the military overthrew the Bhutto regime. **[9]** General Zia al-Haq, the Chief of Military Staff and the Coup leader, announced a reconciliation and called back soldiers, and freed NAP politicians and prison workers as a gesture of goodwill.

The last two decades of Twentieth century were proven quite peaceful for Balochistan. During these years, nationalists were less restive because the government had launched some development schemes—construction of roads and small dams and the expansion of power transmission and grid stations, which boosted agriculture. Quetta received piped gas from Sui for the first time since its discovery four decades earlier. **[10]** The fifth and ongoing insurgency began in 2005.The present problem of Baloch-Islamabad started with the Baloch-development initiatives. The port of Gwadar demonstrated the Nationalist and the Federal Government of Baloch as a bone of dispute. This uprising grew when the then Chief executive Pervez Musharraf declared an all-out battle over Balochistan in March 2005. **[11]** The insurgency got uprising with the death of Baloch prominent leader Nawab Akbar Bhugti. It is estimated that in Balochistan, between 2004 and 2015, almost 1,000 people were killed during militant attacks. **[12]**

3.CAUSES OF CONFLICT

The root causes of Conflict in Balochistan have been based on unaddressed grievances of Baloch people living in extreme poverty, Lack of autonomy, lack of government and military representation of Baloch, economic oppression, Intra tribal clashes and even the foreign intervention. The Baluch citizens, have never had their required political representation even in military. At times, the provincial council of Balochistan could not conclude its term because of the central government's inclination towards political isolation. Another main cause of the ongoing crisis is the exploitation of natural gas in Balochistan. The Baloch nationalists are of the view that the federal government is not distributing a decent share of its revenues to the local people. Natural gas was found in Sui in 1952 and sent to various parts of Pakistan in 1955 but Balochistan remained deprived of it even till today only 13 towns have the natural gas facility, with 59% of the urban population in the province still without the basic energy commodity. **[13]** Further In the province of Balochistan there are a host of militant parties, including Al Qaeda, Quetta Shura and Taliban and the Tahreek Taliban. These groups' activities have made the crisis situation more complex.

4.STRATEGIC SIGNIFICANCE OF BALOCHISTAN

Balochistan remains a zone of keen interest for great powers due to its strategic position. The coastline of Balochistan is 770 KM. It is the perfect location to further develop roads, railways and pipelines to the Middle East, Central Asia and South Asia, owing to the geography of Balochistan. The British used this area as a buffer zone prior to independence. It was managed by Sardars. **[14]** The signing of an agreement with China of $46 billion Economic Corridor (CPEC) represents an opportunity to examine its ability to become a foreign trading

Centre. The construction of Gwadar port had boosted the significance of province. This port has potential to become Pakistan's overseas trading Centre.

5. INTERNAL AND EXTERNAL ACTORS OF CONFLICT

Balochistan due to its strategic significance remains key factor for great powers. As Balochistan has become a deprived region both politically and economically, its vulnerabilities have once again given sufficient forms for international participation. [15] At internal level state is fighting against Baloch nationalists comprising different anti state groups e,g Baloch Liberation Army, Baloch Liberation United Front and many others. These groups have a narrative that their resources are being exploited by state they are fighting on the ideology of Greater Balochistan for independence. Balochistan has been the Centre of attraction for foreign actors who helped and concealed these nationalists of Baloch in the past and continue to support them today.

External actors also play an important role in destabilizing the region. Through manipulating Balochistan, the western imperial forces are striving to open up the stage of hostility towards Afghanistan and Iran. Death of Chinese engineers, staff and customers are interconnected to it. [16] In the past and even today, Balochistan's insurgencies have an external relationship in terms of shelter, financial assistance and political support. Balochistan has always been a major factor holding the Baloch people dull, unaided and underprivileged, under the tyrannical norms of Sardars (tribal chiefs). Thus, the 'players of regional policy' have significantly inducted focus. It is in the benefit not just of the Americans but also of Russia and India. In Balochistan the root cause of violence is not domestic poverty or lack of progress, but the hidden activities of international intelligence agencies. Internal problems may be a reason for inflaming the crisis, but foreign intervention in Balochistan's internal affairs is a root cause. [17]

6. CONFLICT RESOLUTION ATTEMPTS

In different era's democratic and military governments try to address Baloch grievances with different kind of initiatives without lasting results. Efforts began by enhancing provincial status within 1973 constitutional federation. Increased federal power and utility systems and increased financial divisions by pacakge Aghaz-e-Haqooq-e-Balochistan,7th NFC and 18th provincial amendment. [18] The Eighteenth Amendment and the seventh NFC Award provided Balochistan the greatest benefit. Its bid in the regional pool rose from

5% to 9.09%.In addition, the seventh NFC Award also revised the Gas Enhancement Surcharge (GDS) measurement formula and accepted the retroactive payment to Balochistan of unpaid GDS debts on the basis of the current formulation. [19] The condition of mediation and accommodation has given rise to hopes that the much-needed move for dispute settlement in Balochistan will be implemented but unfortunately not even a single package or initiative was successful because all of them were not even implemented partly.

7.WAY FORWARD

Balochistan need a solution in which all the stakeholders, state its organs, judiciary, Council of common interest play their role whole heartedly. The rampant corruption among these institutions become a reason of failure in resolving the conflict.

1. Instead of providing municipal privileges, political governance used to differ from their mandate; they exert extremely power to regulate conditions of Baloch. Collaboration between the public and the press is necessary to emphasize Rulers not to depart from their mandate and also to relieve stress on external factors that seek to influence the government's plans.

2. Confidence building measures are needed to regain the trust of deprived Baloch people. It could be a logical conclusion of Death Case of Nawab Akbar khan Bhugti, eliminating the role of force in Balochistan, resolve the issue of missing persons. Long-term population friendly strategies should integrate Balochistan into mainstream national life.

3. Mega schemes are vital for financial development but even regional conditions are to be met by the federal authorities. Regardless on whatever action is taken, it must focus entirely on the wishes and key needs of the indigenous people who have the greatest possible benefit. The real fix is not total dependence on mega-projects. It is necessary instead to pay due consideration to address day-to-day questions about individuals such as their need for employment, fair pay, protected travel services, the fulfilment of basic needs and life safety assurances and proper legal care.

4. Employment in the province depends entirely on the public sector and not everyone in the government sector can adapt. The province is endowed with many natural resources, but there is hardly any work that can accommodate large masses there. In these regions, urgent and appropriate attention must be paid to job creation.

5. Instead of granting human rights, successive governments used to deviate from their mandate; they violently use coercion to suppress the demands of Baloch. For this reason, there is a need for civil society-media partnerships to put pressure on leaders not to shift their mandates and to counter press the external powers trying to change government policies.

6. Reconciliation should be used for the purposes of resolving the Baloch dilemma. A favorable reconciliation climate must be established and attempts taken to re-establish people's trust after establishing a viable environment and then we will negotiate with the local people.

7. Building cantonments in Balochistan must be stopped for certain period and the reconstruction should only be started with the will of locals. Further, state should make it sure to Baloch people that they will not be converted into minority in their own region.

8. The 18 Amendments and the NFC Award ,Aghaz-e-Haqooq Balochistan were entirely unsuccessful mostly due to very serious management challenges. It is essential to develop a robust and systematic evidence framework to address Balochistan's management problems. The whole lack of quality government made the situation much worse. No programme is ever successful if the government and the provinces do not devise a policy that ensures the appointment of competent, trustworthy and honest officers that are unlike provincial politics.

9. Armed resistance among some elements of Baloch is now marked by a lack of hope and a loss of confidence in the country as Pakistani citizens due to the extreme disaffection and the injustice they have perceived. Re-establishing this dream is the secret to progress. Baloch wants a rethink in mental subversion by developing an innovative and credible policy that is sincerely and credibly strategized.

10. CONCLUSION

Balochistan province remains a conflicting region since the day of its accession with Pakistan. It has faces five insurgencies. The conflict in Balochistan is not a new phenomenon and only a single authority could not be accused of the ongoing unrest. Instead, it was the refusal to react to the actual grievances of the Baluch peoples of successive political and military regimes. This persistent marginalization and under-developed mechanism had led to the creation of internal and external fault lines, which dissident nationalists and external authorities further exploited. People living in Balochistan are not against the development of their province they are basically against the exploitation of it. They are right at some extent because despite richness in resources the province is least developed and people are living a below average life without basic facilities of health and education. This confidence deficit must be bridged immensely in order to remove the fault lines of the province. In addition, external forces manipulate the precarious situation of the province. State needs to focus on all these areas to bring peace and stability in province.

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INDIA'S GROWING STRATEGIC CAPABILITIES A THREAT TO SOUTH ASIA

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Abstract

It is always a challenge to analyze the transforming geostrategic contours of the world. The region of South Asia received an immediate attention of the international world when India (followed by Pakistan) conducted nuclear tests and showed their dominance and strategic capabilities to each other. After that, both countries evolved into arms race. The world and specifically the region of South Asia has experienced a massive boom in the military capabilities of India. The emerging major global power in wxzorld order due to its large military, fast growing economy and political affiliations with other major powers of the world. In some last two decades or so, India invested heavily in acquiring latest technologies from Russia, USA, France and Israel. India's technological acquisitions and emerging capabilities, and her eagerness to get new technologies of hypersonic weapons, anti-satellite weapons, and advancement in the domains of space, maritime, nuclear energy exacerbate the asymmetric strategic dynamics. Furthermore, these rapidly growing strategic capabilities of India would largely help in pursuing her hegemonic ambitions in the region. India is looking to combat the rising strength and involvement of China in the Indian Ocean and her growing maritime capabilities. In point, India sees her hegemonic status is in a peril because of close strategic ties between China and Pakistan. India's aggressive ambitions towards Pakistan, and enhancing her strategic capabilities surely results to a precarious outcome in the region because of India's influence, presence and hegemonic status in South Asia. Moreover, a major challenge to South Asia's security and stability arouse because of the Modi led Indian government affiliations with the Hindutva's supporting agencies.

Keywords: South Asia, India, Nuclear Doctrinal Shift, Maritime Capabilities, Space Capabilities

1. Introduction

The region of South Asia have come across intermittent disruption and the countries in the region had achieved an autonomous status ever since the British departed from the region. South Asia is one of the most volatile areas in the world. South Asia is a strategic entity and its outer boundary forms India's own natural defense perimeters. India as a prominent power in the region sees South Asia as its sphere of influence. The region of South Asia and its stability seems to be a fragile one because of the massive strategic build up in the capabilities of Indian forces. This rapid strategic growth of India have expanded traditional inequalities in South Asia and have become a source of causing the region more vulnerable. [1] India as a core country shapes the environment of the South Asia region. India must deal with comprehensive defensive and safety considerations. India by far the most technological modern and industrial state in the region, including a massive weaponry industry which is considered to be the largest in size within the emerging states, due to its size, scale and manufacturing diversity, and research and development resources in South Asia. [2] The longstanding strategic policy of India has been among the most impressive qualities of India as a sovereign state is the emerging regional and major power in the world order. In recent times, India's defence budget has steadily risen and is now one of western and Russian military equipment's largest purchasers. The rise in India's military spending is driven by its fast-growing economy and is also seen as a signal of its global and regional aspirations. The increased military expenditure of India would certainly significantly boost its military capacity and make it possible for it to consider aggressive military options in the region. [3] India's ongoing military modernization and advancement threatens to upset the delicate conventional military balance in the region, and it had created worrisome situation within the other states of the region. India has developed its military capability and aims to play an active and important regional role. India also does not want other major powers, especially at bilateral level, to be recognized as a customer state. And India wants to understand its influence not only at the state level but also internationally when negotiating with its neighbors in South Asia. [4]

2. India's Strategic Sovereignty and Growing Capabilities

India is at a pivotal face of history. The extraordinary changes and developments emerged in the region in last two decades have fundamentally transformed India's strategic capabilities, economy and her status as an emerging major power in world order. These developments have created the possibility that India can be a reasonably prosperous and equitable state on the world map. [5] Any strategy needs a goal and a purpose. And India's goal was apparent at the day of her independence, and the goal was the transformation of India into a strong, prosperous and modern state in the global world. A State that 'protects and ensures India's rectitude, her peoples, values and their properties and open new doors and opportunities for the Indian to evolve and transform into a modern state on the world map where each Indian can fully reach and achieve their potentials. [6] India has acknowledged the importance of economic growth as a factor in domestic poverty alleviation and for the realization of national interests in the international arena. India is keen on strengthening her strategic fold in South Asia. Traditionally, "India has put forward 'strategic sovereignty' as a pivotal source in her foreign policy strategy." The state of India has also promoted her adjacent states, not just to dissuade alien authorities from entering in the country. India is showing concern with regard to unilateral military commitments in "Goa, Sikkim, Nepal, Bangladesh, Sri Lanka and the Maldives", and to her diplomatic commitments towards 'Eastern Asia' in reply to the presence of China in 'Southern Asia'. India's self-proclaimed of sovereign state position as a dominant regional power in South Asia, and further, New Delhi's position as world's prime weaponries importer shown concern to the stability of the region. [7] The fundamental aspect of India's desire to achieve a great power status in the Indian Ocean is due to her modern military forces, gigantic population, enhanced maritime capabilities and power, massive space program and, also because of enormous progress in the economic sector and considered as to be one of the region biggest economies. India's increased military capacity and economic strength have made it a major regional power in South Asia that plays an extremely important role in the region's political affairs. [8] India's successes have now prompted major authorities like the USA, Russia and China to recognize, or at least parallel, the validity of her interests in defence and influence in 'Central Asia' and pursue Indian support for its goals. In other words, these great powers need Indian friendship now as much as their friendship is, if not even more, needed by India. [9]

3. Fortification and Advancement of Indian Military Forces

Advancement of military forces is a complex process and it involves all the possible changes occurs in the material capacity to meet the strategic objectives. Advancement is the expression of the growth of national ambitions. And India has formulated certain policies and shall contemplate on the military means to achieve her strategic goals. Further, this needs astute planning and strategy in the constantly changing environment. As Indian military thinkers are more focused toward India's land borders due to a long history of the border disputes. However, in the changing circumstances, variety of other perils like territorial, environmental, natural disaster, migration, drug trafficking, radicalization, terrorism, piracy and also the threat to cyber, nuclear and energy security opened ways for the advancement of Indian military forces. [10] India as a country has progress massively in economic sector and arouse as a major political force that compelled her to promote her military powers through transforming of her strategic outlook and revamping military. This has further revolutionized its strategic thinking, military outlook and defense capabilities. In addition, Indian military has undergone through a massive military overhaul, transformation in its strategic doctrines and operational capabilities. Furthermore, the induction of Airborne Warning and Control System (AWACS) systems, naval carriers, anti-ship missiles and Indian Navy Ship (INS) Arihant has fortified the Indian forces. Indian efforts to revolutionize its military to offset the existing power equation and impose a conventional asymmetry. [11]

4. India's Growing Maritime Capabilities

Maritime safety is one of the most recent mottoes in foreign affairs. Over the past decade, major players in maritime politics, ocean governance and defence have begun to incorporate maritime safety into their mandate or have reshaped their practice. [12] India's maritime policy and official Indian reports now consistently use the phrase 'maritime strategy' instead of Mahanian 'naval strategy', which has two major objectives: to protect the security of India and the independence of its territory and to secure India's maritime trading routes. The same papers list a series of risks to these interests. Some are marked 'non-traditional'. Seafarers, hacking, and uncontrolled investment plans are among these. Additional threats faced by States with coordinated military capabilities and capital which are conventional in their harbour adversarial attitude and hostility to India. The tone and tenor of the statements in Indian maritime strategy indicate that

while non-traditional menaces are of major significance, traditional challenges do exist. [13] In their bilateral relations, the US and India have crossed proverbial Rubicon, which is the core thrust of maritime cooperation. Marine-to-Marine cooperation among India and the US has been "the most successful field of bilateral relations". The maritime sector, including the Indian Ocean and the Indo-Pacific, has become the domain for identifying common threats and objectives in the greater Asian seabed. In future Asian geopolitics, the role of the Indian Ocean and the broader Indo-Pacific area will be the guiding force behind the United States-India relationship. [14] India absolves its strategic focus as its growing maritime influence and maritime ambitions of solely continental geopolitical views of the oceans. Maritime security is also a primary feature of the US-India bilateral and strategic partnership. Not only have Indian and American navies conducted drills, staff exchanges, bilateral staff discussions, visits to ports and common training in the last ten years, but they have had tactical collaboration on four occasions also beyond the UN mandate, the usual choice of India to make use of their forces in collaboration. Both navies have achieved an interoperability standard and an ability to cooperate in the fight against all ocean threats. [15] A range of high-end assets, including "P-8, Underwater Surveillance and Anti-Submarine Warfare, Apache Helicopters, CH-47 Chinook, Transport Helicopters, C-17 and C-130" transportation aircraft and several other units, such as MH-60R Seahawk and Large Aircraft Infrared Counter measurements, have been part of the US-India maritime cooperation. The Sea Guardian UAS produced by General Atomics and the U.S continues to endorse the advocacy of the Missile Martin F-21 MTCR Category 1 unmanaged aerial system, and the Boeing F/A-18 Super Hornet and F-15EX Eagle as part of potential fighter aviation acquisitions of India. A possible selection would improve India's military capacities, increase the military interoperability between the US and India and safeguard common security interests in the area of the Indo-Pacific. [16] Now the Vision-2030 for Maritime India, a 10-year roadmap aimed at overhauling the maritime industry, envisages investing 3 lakh crores in port ventures to provide jobs for 20 lakh persons in return. By operating Vizhinjam port, and developing a transportation zone in Kanya kumari and Champbell Bay, the state is planning to increase Indian cargo transshipments from 25% in Indian ports in 2020 to more than 75% by 2030. [17]

5. India's Enhanced Space Capabilities

The space program of India is a sign of the country's advanced technological capacities and her increasing regional and international reputation and authority. The space program of India is primarily concerned with technological, commercial and space-specific uses, and mainly use for the purpose of development projects in urban areas and furthermore for the purpose of recovery of uncontrolled agricultural land. The military forces in India are getting freedom in using space as a tool for getting more dedicated satellites surveillance and recognition system with satellite-based technology that provides India with dedicated military intelligence. India's satellite-based military monitoring and identification scheme provides devoted military intelligence to India and this helps India in purchasing more dedicated satellites to create a more robust Integrated Guided Missile Development Program (IGMDP). The Indian space force relies on dual-use of commercial satellites unless it had floated a military dedicated satellite system. For example, INSAT series satellites used for the transmission of digital data, teleconferencing and remote communication. The Indian Air Force have recently expressed their concerns and demanded their specialized satellites systems that enable the forces to achieve their desired objectives and goals. [19] The Indian Space Research Organization (ISRO) heads discloses that ISRO in one of its subsidiary centers producing the state of the art propulsion facilities that includes electric, hybrid, cryogenic and nuclear power facilities for "Liquid Propulsion Systems Centre (LPSC)" for the space launches. Alternatively, the design of these propulsion systems for SLVs may be used to further refine the region's long-range missile program, such as the BMD and ASAT initiatives. Therefore, discriminatory secured technological access to India through the MTCR platform for dual technology seems to be an alarming situation for peace in the region and further destabilize the stability of South Asia. [20]

6. Nuclear Doctrinal Shift of India

No First Use is the fundamental concept of the Indian Nuclear Doctrine. No First Use is the fundamental theme of the Indian Nuclear Doctrine. India under the government of former Prime Minister Indira Gandhi had her "first nuclear test" in May 1974. And India' recognition around the world has improved because of the nuclear tests. Without signing the Non-Proliferation Treaty, India has become the first nuclear nation (NPT). Following the nuclear testing, India became restricted by the international community. India has demonstrated to the world that India is a responsible nation and its nuclear warheads simply aimed at safeguarding the country's security and borders so that no nation invades. [21] A non-official representatives of strategic specialist in March 2012, build up by the 'New Delhi Institute of Peace and Conflict Studies', originated an alternative "Nuclear Doctrine" for India as well, that predominantly abided by the

"Official Doctrine", except for rejecting "mass" characterization to any atrocities committed on India. [20] The Indian Defense Minister announced following Balakot's tussle between the two nuclear weapons states, while India stranded to her "no first use" engagement, and the afterward strategy would rely on the occurrence, happenings between the relations of the states, which aforementioned by the professionals and analysts by adding that to a degree of uncertainty to the core national security doctrine. [22]

7. Peril of Nuclear Arms Race in South Asia

India's Growing strategic capabilities are becoming a challenge for the strategic stability of South Asia. The ties between India and Pakistan are a key basis for South Asian security and stability. At the end of the British rule, first tension hit the area. The struggle between Indian Muslims who wanted a separate house and Hindus who were against their aspirations. Since the unification of the two nations, the conflict continued. In the last fifty-five years, India-Pakistan has remained highly affected by short, intermittent stages of normal ties. The competition between the two countries in Kashmir is most evident in animosity. [23] The development of Indian military capacities in the traditional military geographical balance has resulted in asymmetry. The recent acquisition of nuclear capability by India and Pakistan is compounding the risk of this imbalance. The architecture and acquisition programs of India are also potentially a major obstacle for South Asia.

8. Conclusion

South Asia as a region is considered as one of the least economically assimilated area in the whole global world. In South Asia there is an emerging instability that is heated with the growing Indian strategic capabilities. The building up of Indian security exacerbates the impression of a threat that instigates a reaction. This adds to more uncertainty and an escalation chance. The rapid modernization of India's space and sea forces has seriously threatened the region's peace and defence. India's growth was not only due to the increasing power of the economy. Indeed, India emerged as the bully of South Asia and gained unparalleled opportunities for self-government in and outside the region. And most Indian planners, theorists, and scholars are beginning to believe that now is the time for the smaller countries in the region to learn not only to live with Indian ambitions but to work with them on a subordinate basis. Indo-US strategic nexus has enhanced India's military and conventional capabilities while South Asia is a region of nuclear weaponry states in this scenario the deterrence stability becomes weaker.

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Advanced Compact Power System: An Overview

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Abstract

The renewed interest in very small modular reactors for power generation of space exploration missions focuses on the power systems in kilo-power range that has minimum moving parts such as turbines and pumps. Because of their small size, mobility, simple maintenance requirements and safety, these reactors are also attractive for meeting the off-grid energy requirements. In design of these reactors, there are number of options for extracting the heat from the core and power conversion systems. For heat removal, two-phase heat pipes with liquid metals such as potassium, lithium, or sodium as working fluid are suitable candidates, while conventional Stirling engine and solid-state thermoelectric generation are the available options for power conversion. Thermoelectric generation has a direct thermal-to-electricity route with no moving parts while the Stirling engine goes through the thermal to mechanical to electrical conversion route through a crankshaft.

For the neutronics analysis, Monte Carlo simulations can be used to establish the criticality of the design, and heat removal capability can be estimated using the empirical relations. The control and automation in a kilo-power micronuclear reactor, based on the timely operation of sensors and actuators is necessary for steady state power generation. Reactor control is achieved by boron carbide layers on rotating drums in a beryllium oxide reflector surrounding the core. The control system can actuate the control drum mechanism which controls the production of heat flux to keep the power at constant level. Thus, for a coupled state-space model to determine the time-dependent response, dynamic modeling can be carried out in the MATLAB Simulink environment. This study presents a brief overview of the advanced compact power system design that is suitable for space applications and off-grid installation.

Keywords: energy; heat pipe; Monte Carlo.

1. INTRODUCTION

Small Modular Reactors (SMR) are defined as nuclear reactors with power output of less than 300MW. They are regarded as modular because they can be manufactured completely in a factory and delivered to a remote site for installation [1]. Their applications range from space propulsion systems to compact off-grid electricity generation systems and require high heat removal system. In such environments, conventional heat transport fluids such as water and gases are replaced with more attractive high-temperature metallic coolants such as lithium, potassium, and sodium in two-phase heat pipes without forced convection.

A summary of basic features of SMRs as well as some applications other than energy production such as desalination and general process heat for various industries, with some appropriate design changes is provided by [2].

For the purpose of designing a suitable control algorithm and for consequent overall performance of a reactor, understanding reactor dynamics is crucial. There is a need of appropriate reactor dynamic models with changing and increasing efforts into development of SMRs. One challenging aspect is the fact that different SMR designs require different considerations [3]. Meeting the safe operating criteria is must for any industry regardless the size and capacity. From design perspective, nuclear power plants are complex systems. They require a control mechanism for heat removal management be it passive or active.

A number of design options are being researched for safe and optimal operation of SMRs. SMRs being researched and developed have various energy capacities depending on their applications and consequently, have different control mechanisms for safe operations. CAREM-25 [4]–[6] is a 100 MWt prototype light water reactor and uses natural circulation for core cooling. Stable, robust, low-order and simple controllers were designed for both high- and low-power operation of the CAREM reactor [7].

A number of other projects such as Evinci, mPower, and NuScale with the goal of commercialization of SMRs are at various stages of development. [8]–[12].

With the advances and interest in small modular reactors, the research is now focused on even

compact passively cooled modular reactors due to their applications in space exploration as well as off-grid energy requirements. These compact power plants are typically in kWe range, classified as Very Small Modular Reactors (vSMR) and require high heat removal systems. Kilopower Reactor Using Stirling TechnologY recently demonstrated the use of nuclear power sources in kilo-power range for space exploration missions [13], [14]. Based on cooling technology, micronuclear reactors can be classified as heat pipe cooled reactors, liquid metal, and gas cooled reactors. Heat pipe cooled reactors have significant advantages over other types of reactors [15]. High pressure cooling systems or gas-based cooling solutions make the system complex and heavy and significantly limit their applications. Heat pipe cooled reactors operate at much lower pressures. This study presents an overview of three crucial aspects in the design of vSMR.

2. NEUTRONICS

The advanced compact power system is a vSMR type design typically for specialized applications in future standalone micro-grid baseload plants, space, and underwater systems. The design is compact in size and configuration with conventional and innovative safety systems. These advanced micronuclear reactor designs use high enriched uranium fuel and heat pipes for power generation. The neutronics analysis of the advanced compact power system design with high enriched uranium nitride fuel rods in a monolith of high temperature capable Zr-1Nb material with heat pipes containing liquid metals operating at $\approx$1200 K can be carried out using Monte Carlo simulations.

The core has a beryllium oxide reflector with rotating control drums lined with boron carbide absorber layers. This analysis uses the OpenMC Monte Carlo code for computation of power [16]. The core arrangement as well as the movement of these drums is anticipated to result in flux peaking which could subsequently result in varying heat removal requirements from the heat pipes [17]. Thus, another aspect to consider is the effects of lowering the enrichment in the innermost and outermost zones and the effects of such modification on the overall multiplication factor of the system. Figure 1 illustrates the block diagram of the components of advanced compact power system.
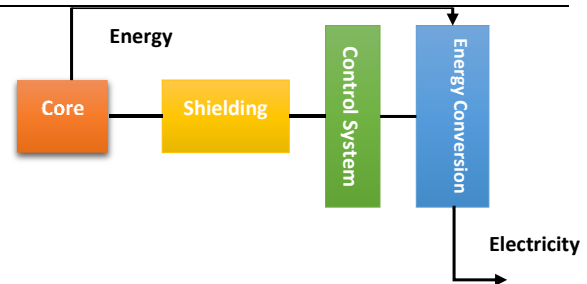
Fig. 1. Block diagram

3. THERMAL HYDRAULICS

Thermal Hydraulics section is dedicated for conceptual design and assessment of the reactor core temperature, heat removal system from reactor core based on heat pipe to provide sufficient heat transport capability and primary heat exchanger which exchanges heat with working fluid running in power conversion cycle.

Nuclear fuel experiences inhospitable thermal, mechanical, and radiations conditions in the reactor core and operates within the specified limits during operation. The fission reactions take place in fuel pellets where the temperature exceeds 1000°C (1832°F) at the center. Therefore, the temperature distribution for a single fuel rod and for the whole reactor core is important for its designing and operation under normal conditions.

Heat pipe micro nuclear reactors are designed to operate for more than 10 years without refueling and to operate in a passive mode at pressures below the atmospheric pressure. The reactor core is a monolithic solid core made of stainless steel with channels for fuel rods and heat pipes. The heat pipes are used to remove fission and decay heat from the reactor core. The evaporation section of the heat pipe is located inside the reactor core while the condensation section is placed in the primary heat exchanger.

Each heat pipe is sealed and contains working fluid -- sodium, potassium or lithium, to transport heat from the evaporator section to the condenser section outside the core. It is this heat energy that is used for power generation. For the selection of feasible working fluid, capillary limit of the heat pipes can be calculated using the Eq.(1-3) [18]:

$$Q_c = \frac{\sigma_l.\rho_l.l_v}{\mu_l}.\frac{K.A_w}{l_{eff}}.\left(\frac{2}{r_{eff}} - \frac{\rho_l.g.l_t.\cos\Psi}{\sigma_l}\right) \qquad (1)$$

$$r_{eff} = 0.1*d \qquad (2)$$

$$K = \frac{(d^2.\varepsilon^3)}{150.(1-\varepsilon)^2} \qquad (3)$$

4. CONTROL STRATEGY

With increasing efforts towards the development and commercialization of advanced

compact and modular power systems, the need for appropriate dynamic models and control strategies arises. Although a number of studies are being carried out in design of SMRs for safety and smooth operation, there is a dearth of control algorithms and strategies to maintain the system within operational parameters. In addition to that, different designs also require different control strategies, as some designs incorporate a single control rod while others use multiple control drums to maintain stable power.

There is also the matter of flat or smooth power distribution inside the core and smooth and continuous removal of heat from the core using heat pipes to Stirling engine or thermoelectric generator. Rapidly changing dynamics of the plant due to varying power requirements makes this a complicated time varying problem. A responsive and reliable control algorithm is a crucial element and first step after the design of a system is selection of a suitable control scheme.

Conventional controllers can be seen in all control systems of the nuclear power plants. For example, the reactor control system uses the classical compensators and filters (i.e., phase lead/lag and PID controllers). Using a reference temperature, determined by the turbine load, the average temperature of the core can thus be controlled. Based on the deviation of the core temperature and reactor power from the reference or desired value, a signal is generated which adjusts the insertion or withdrawal of the control rods by controlling the speed. However, with conventional controllers i) closed loop stability is not guaranteed in the condition of large power demand variations, and ii) optimal tuning of the compensators and filters is difficult due to variations in nuclear system parameters, nonlinear dynamics, and complex feedback effects.

The study of neutron population is also of great importance in nuclear reactor kinetics. That is because it plays an essential role in sustaining the fission reactions in a nuclear reactor and is a priority in nuclear safety. Due to apparent simplicity, the time-dependent transport equations, modeling both prompt and delayed neutrons, are widely used to study the behavior of the system. A simpler model based on point kinetics model can be used to estimate the overall dynamic characteristics.

The idea is that a method which fails on simpler model which is developed using point kinetics and considers the reactor as a single point or region, will also most definitely fail when a reactor is considered with many regions.

The point kinetics equations are linear and coupled first-order ordinary differential equations that express the time dependence of neutron population, and the change of reactivity and temperature due to a change in neutron density and delayed neutron precursor concentration. These equations are solved to study the behavior of the neutron population. Point kinetics equations with one group delayed neutrons are written in the form of Eq.(4-5) :

$$\frac{dn}{dt} = \frac{\rho(t) - \beta}{\Lambda} n(t) + \lambda C(t) \qquad (4)$$

$$\frac{dc(t)}{dt} = \frac{\beta}{\Lambda} n(t) - \lambda C(t) \qquad (5)$$

where $n(t)$ is neutron density (or power in MW), $\rho(t)$ is the reactivity, t is the time, λ is the decay constant, β is the fraction of the delayed neutrons, $C(t)$ is the density of delayed neutron precursors (or latent power in MW), and Λ is the generation time.

Negative temperature feedback is also considered as part of the system and is given as Eq.(6-7):

$$\rho(t) = \rho_0 - \alpha[T(t) - T_0] \qquad (6)$$

$$\frac{dT(t)}{dt} = K_c n(t) \qquad (7)$$

where $T(t)$ is the temperature of the reactor, K_c is the reciprocal of the thermal capacity of the reactor (K/MW*sec), T_0 is the initial temperature of the reactor (K), and α is the temperature coefficient of reactivity (K^{-1}).

The initial delayed neutron precursor density is related to the neutron density through the reactivity as given in Eq.(8)

$$C(0) = \frac{\beta - \rho_0}{\Lambda \lambda} n_0. \qquad (8)$$

A Simulink model can provide a complete and clearer representation of the point kinetics equations for one-group delayed neutrons with negative temperature feedback. Variables that can be controlled are the initial step reactivity, initial condition of precursor density, and initial power. MATLAB and Simulink can thus be used to design and simulate the control strategy for the power system.

5. CONCLUSIONS

This work provides a brief overview of the critical design aspects for an advanced compact power system that is based on a vSMR. Critical design stages considered include neutronics, thermal hydraulics, and control strategies. The advanced compact power system is designed to meet energy requirements for more than ten years. However,

there are a number of design challenges that require research and considerations before such power systems are commercialized. These challenges include challenges related to uranium enrichment and distribution in the core, shielding, and heat pipes. A fault in one of the heat pipes can result in power peaking or uneven distribution of heat in the core. It is hoped that this work will encourage further research of heat pipe cooled very small modular reactors.

NOMENCLATURE

A_w wick cross-sectional area (m^2)

$C(t)$ density of delayed neutron precursors

K wick permeability (m^2)

K_c reciprocal of the thermal capacity of the reactor (K/MW*sec)

MW_e megawatt electric

MW_t megawatt thermal

T_0 initial temperature of the reactor (K)

d sphere diameter/grain size

g acceleration due to gravity

h wick thickness

kW_e kilowatt electric

$vSMR$ very small modular reactor

l_a adiabatic region (m)

l_e evaporator region (m)

l_c condenser region (m)

l_v latent heat of vaporization

l_{eff} effective length of the heat pipe (m)

l_t length of the heat pipe (m)

r_{eff} wick capillary radius in the evaporator (m)

r_i inner container radius (m)

t time (s)

α temperature coefficient of reactivity (K^{-1})

β fraction of the delayed neutrons

Ψ tilt angle from vertical axis (gravity vector)

ρ_l liquid density ($\frac{kg}{m^3}$)

σ_l surface tension

$n(t)$ neutron density

$\rho(t)$ reactivity

λ decay constant

Λ generation time

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ABSTRACTS

AUJOGR-21101

IMPACT OF TEMPERATURE ON STRUCTURAL, MICROSTRUCTURAL AND DIELECTRIC PROPERTIES OF BISMUTH FERRITE

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Abstract: Single phase bismuth ferrite $BiFeO_3$ (BOF) was prepared by co-precipitation technique at low temperature (85°C). The powder was calcined at 450°C, 550°C and 650°C for 1 hour. XRD analysis confirmed hexagonal phase formation. Crystallite size was estimated from the XRD data that showed an increasing trend with the elevated calcination temperatures. Differential Scanning Calorimetry (DSC) was carried out for phase transformation (α to β), Néel temperature (TN) and melting point temperatures. The variation in microstructures of the BFO pallets with increasing sintering temperatures were studied by Scanning Electron Microscopy (SEM). Electrical ac measurements were carried out within frequency range of 20Hz to 3MHz in this way dielectric constant (έ), dielectric loss (tan δ), and ac conductivity (бAC) were also determined. Magnetic properties of BFO powder were studied by M-H loop by utilizing vibrating sample magnetometer (VSM) and ferroelectric properties were confirmed from P-E loop. Both magnetic and ferroelectric properties were carried out at room temperature

AUJOGR-21102

STRUCTURAL AND CONDUCTION BEHAVIOR OF BISMUTH DOPED GADOLINIUM-CERIA ELECTROLYTE

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Abstract: Four samples with composition $Ce_{0.75}Gd_{0.25-x}Bi_xO_{2-\delta}$ (x=0.0, 0.05, 0.10, 0.15) were synthesized to study the structural and conduction properties. The structural analysis through x-ray diffraction (XRD), morphology analysis by scanning electron microscopy (SEM) and electrical measurements including dielectric constant, dielectric loss tangent, AC conductivity and impedance were carried out to characterize these materials for electrolyte applications. An enhancement in electrical conductivity is observed by the doping of bismuth in the samples. Therefore, Gd-Ceria doped with Bismuth appears to be a good candidate for electrolyte applications

AUJOGR-21103

STRUCTURAL AND CATION DISTRIBUTION IN ZINC DOPED COBALT SOFT NANO FERRITES

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Abstract: Synthesis of $Co_{(1-x)}Zn_xFe_2O_4$ with $0 \leq x \leq 0.6$ by the co-precipitation method is reported along with the structural properties observed by the X-ray diffraction. The variation in the lattice constant, volume of the cell, x-ray density, average crystallite size and the specific surface area were obtained as a function of x. The values of cation distribution in tetrahedral and octahedral bond length dAx and dBx, tetrahedral edge, shared and unshared octahedral edges dAXE , dBXE and dBXEU have been estimated, using the observed values of the lattice constant and the oxygen positional parameter for all the samples

AUJOGR-21201

SUSTAINABILITY DILEMMA FOR STAKEHOLDERS OF PLASTIC BAGS

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Abstract: This case study has been written for the students of management sciences. Many subjects in management area are now teaching the sustainable development practices for businesses. This case study typically deals with that. This case study is useful for under-graduate level course of management sciences especially in the courses such as HRM, Change Management and Strategic Management etc. This teaching case has discussed a policy level initiative of government in Pakistan to ban the use of single user plastic bags in Islamabad. This caused an unrest in the market and the newly available biodegradable bags option were costly for businesses and customers. Hence, that caused a dilemma for them. Expected learning outcomes are that the students would become more aware about the role of sustainability in the modern age of 21st century. Detailed teaching notes are available for this case study.

THE IMPACT OF INFORMATION TECHNOLOGY ON PROJECTS TO GET COMPETITIVE ADVANTAGE IN LOGISTIC FIRMS

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Abstract: This paper focuses on the impact of information technology on projects to get competitive advantages in logistics firms that are situate in Islamabad. We targeted the 3PL firms for our data collection and a small questionnaire was developed to investigate the purpose of the paper. After analyzing the data we found that IT has a significant and remarkable impact on projects to achieve the competitive advantages. A higher focus on IT may improve the project's or firms competitive advantages. Our findings provide quite valuable guidance. Managers can know the importance of IT in logistics and how it can help them to achieve the competitive advantages.

ROLE OF PROJECT MANAGER IN PRINCE 2 AND PRACTICE IN INFORMATION TECHNOLOGY (IT) INDUSTRY

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Abstract: Project Managers are the professionals who are responsible for the successful initiation, procurement and the execution of the project which have a defined scope. He guides his team members and motivates them as well. Also he makes the decisions, controls his staff members and resources. This paper focuses on the management skills of the Project Manager, their role in making the project successful and managing the external and internal stakeholders. He must possess all skills including team building, effective communication, analyzing and solution of the problems, etc. PRINCE 2 methodologies and PMBOK are used as a reference here. However, we will be using them for the comparison of the role of Project manager and importance as well. "PRINCE" stands for Projects IN Controlled Environments and is described as the best structured method for effective project management for each and every type of project and PMBOK is used as a standard for managing the project. These 2 are the most successful approaches that are used by the management for the successful accomplishment of the projects. PRINCE2 clearly defines the project life cycle which is based on major processes from "Starting to Closure" of the project except "Planning" and "Directing a Project", because these two processes support the other 6 processes. Whereas, PMBOK defines a clear standard of terminologies used in the field of project management. Our paper will be clearly focused on the importance of the roles of a project manager and the differentiation made by the PRINCE2 and PMBOK respectively. Study has been conducted in Islamabad. Project Managers, coordinators and senior managers were unit of analysis in our study.

AUJOGR-21204

THE KNOWLEDGE TRANSFER MECHANISM: STUDY ON THE NEXUS OF ACOLYTES' COMPETENCIES, RECIPIENT FIRM'S ABSORPTIVE CAPASITY, KNOWLEDGE RECEIVED BY THE RECIPIENT FIRM AND THEIR EFFECT ON THE FIRM'S PERFORMANCE

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Abstract: The purpose of this study is to examine the knowledge transfer process via Acolyte movement by identifying the nexus between Acolytes' competencies, knowledge received by the Recipient firm, Recipient firm's absorptive capacity and the performance of the Recipient firm. The study attempts to investigate this nexus by identifying the three-dimensional acolyte competencies model scilicet ability, motivation and opportunity seeking for transfer of knowledge and empirically scrutinize that how these competencies can affect the knowledge transfer process and the Recipient firm's performance.

AUJOGR-21301

STRATEGIC STABILITY IN SOUTH ASIA

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Abstract: Stability has been the prime concern of every individual on Earth, which is proportional to the stability of a state. However, the concept of stability of a state has been transformed into strategic stability between states who are nuclear possessed. A threat to a state is a threat to its individuals or natives, one way or the other serenity and tranquility can never stagnate to one point, it is always in a spiral or a curl . Strategic stability means complete stability between two or more nuclear possessed nations, where no sign of war can be anticipated. Notwithstanding to the fact that it is not permanent, but its dynamics changes momentarily, for the reason (because) that War is a Universal phenomenon, which can occur at any time and at any place. It never comes with intimation. Certainly, it is utter destruction in eyes of violence. The proponents of stability beholds that nuclear weapons deter aggression and strengthens peace affairs between nuclear possessed nations. "War shall not be the option", they believe. Moving further come the deterrence, which in turns is Strategic stability. Though, the stability is at stake between India and Pakistan for more than a decade and even more concernful over recent developments in the region.

AUJOGR-21302

EMERGING TECHNOLOGIES: CHANGING NATURE OF WAR

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Abstract: 21st century is the century of emerging technologies. These technologies are being a blessing and curse at the same time. States are also involved in a competition for the acquisition of these technologies. Emerging Technologies, if on one hand has serve states, on the other hand it become hazard for states. Emerging technologies such as Artificial Intelligence and cyber technology are one of the major contributors change the nature of war. According to the Future of War program of the New America Foundation, advanced technologies are causing "changes in the essence of warfare." However, the issue is how technological advances can shape the future of war and the state? This is one of the major issues, causing concern among academics and policymakers alike. Despite this, technology is being extensively used in warfare strategies to establish an asymmetric advantage that allows one actor to enforce his will on another. Cyber technology and Artificial intelligence are main game changers in context of South Asia. It is evident; wars are now being fought below the level of threshold, while sitting in the rooms through and media forums and computers rather than in the battle fields. Now day's most important tools and boosters being used in war is cyber technology. New and advanced weapons will be developed as a result of evolving technology,

altering the geopolitical landscape. The use of potentially disruptive technologies would have significant consequences for defence policy; arms control regimes, international security, regional security and, and stability in the South Asian region, which will remain unresolved for a decade or more.

AUJOGR-21303

ETHNO-POLITICAL CONFLICT IN BALOCHISTAN; THE WAY FORWARD

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Abstract: Balochistan, the largest province of Pakistan with richness in resources has now become a hub of ethno-political conflict. Province is surrounded by conflicting historical background in which two parties the state and Baloch Nationalists are fighting. Baloch Nationalists are of view that their resources are being exploited by state without giving them any proper share. People living in Balochistan suffer a lot because of series of insurgencies. Province faces five major insurgencies with a series of multiple root causes. There are three major group of people living in Balochistan Baloch, Baruhi and Pashtoon. The people of Balochistan province are demanding more political autonomy in provincial affairs while only a minority group is fighting for independence. They are living a life of deprivation far from basic facilities. Balochistan have reservoirs of Gold, Copper and other valuable minerals but unfortunately they didn't get proper share from it. Majority of residents of province didn't get clean water, education and health facilities which are giving rise to their grievances. The unaddressed Baloch grievances are the root cause of conflict in current scenario. From a historical perspective different governments try to address the issue with packages like Aghaz-e-Haqooq-e-Balochistan , 7th NFC award and 18th amendment but the corruption and mismanagement of this sensitive affairs and communication gap among both sides remains the issue at same stage. There are many actors, internal and external involved in conflict with their own objectives. They are using deprived local people to attain their objectives. Conflict in Balochistan have a long history but it can be resolved by addressing the grievances of deprived people of Province and giving them their proper share in provincial affairs

AUJOGR-21304

INDIA'S GROWING STRATEGIC CAPABILITIES A THREAT TO SOUTH ASIA

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Abstract: It is always a challenge to analyze the transforming geostrategic contours of the world. The region of South Asia received an immediate attention of the international world when India (followed by Pakistan) conducted nuclear tests and showed their dominance and strategic capabilities to each other. After that, both countries evolved into arms race. The world and especially the region of South Asia has experienced a massive boom in the military capabilities of India. The emerging major global power in world order due to its fast growing economy, large military and political affiliations with other major powers of the world. In some last two decades or so, India invested heavily in acquiring latest technologies from Russia, USA, France and Israel. India's technological acquisitions and emerging capabilities, and her eagerness to get new technologies of hypersonic weapons, anti-satellite weapons, and advancement in the domains of space, maritime, nuclear energy exacerbate the asymmetric strategic dynamics. Furthermore, these rapidly growing strategic capabilities of India would largely help in pursuing her hegemonic ambitions in the region. As India want to counter China's growing influence and presence in the Indian Ocean Region and its increasing maritime capabilities. And on the other hand, India see China and Pakistan a major threat to its hegemonic position in the region. India's hostile intent towards Pakistan and corresponding military capability enhancement can lead towards dangerous consequences due to the increasing India's presence and capabilities in South Asia. Moreover, the current Indian government's association with Hindutva sponsoring organizations will lead to create a massive threat to the stability of South Asia.

AUJOGR-21305   AUJOGR-21306

NUCLEAR STRATEGIC RIVALRY BETWEEN US AND RUSSIA

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Abstract: Nuclear weapons have a vital role in US-Russian relations. The relations between Russia and the United States were determined by a complex interplay of ideologies, political environment, and economic factors that led to shifts in alert cooperation and often bitter superpower rivalry between them over the years. A widening rift between Russia and United States over cruise missiles and increasingly daring patrols of nuclear-capable Russian submarines threatens to end an era of arms control and bring back a risky rivalry between the two dominant nuclear power states of the world. This paper will analyze the rise in tension between two dominant states come at a time when the arms control effort of the post-cold war era is about to lose their momentum. Both states are deploying strategic nuclear warheads against each other and spending billions of dollars to modernize their warheads against each other recently and increasing their arsenals to tackle any misadventures from the adversary. The modernization of the warheads against each other involved a new and revived delivery system during the warfare times. Major power rivalry between Russia and the United States increased mutual suspicion as well as reduced willingness to cooperate different issues, and this new rivalry among them increased the risk of conflict at new heights with potential use of nuclear dimensions and warheads against each other. Due to different political systems and historical traditions between Russia and the United States, this paper will discuss if there is a massive chance of nuclear rivalry in the coming years, which might largely affect the dynamics of global world politics and scenario.

CHINA AS ECONOMIC AND MILITARY POWER; ITS IMPACT ON THE STRATEGIC TRAJECTORY FOR EAST

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Abstract: This research is aimed to determine that China's economic and military transformation, under the Communist regime has the potential to impact the strategic trajectory of the East. Over the long run of economic growth, China came out to be succeeded one with the recognition of many analysts illustrating China as a rising economic power. The startling nation instituted from bartending prior during 3000 B.C to the world's largest trading state comprised agreements, trades, military enhancement, political stability, and quintessential geographic position. Thus, China prompted regional power to a potential great power competent of exerting much influence not only in the East but covering all the Western sides. In this regard, the phenomenon adventure of China's economic expansion extended significant perception in the realm of capital misallocation to accumulate. This research will identify the policies and initiatives for economic prosperity in the region it's "Made in 2025" policy will be discussed. Within the perspective of economic growth, the most influential project of China known as the Belt and Road initiative (BRI) and projects under this, will be deliberated which has been driven upon a strategy of coordination, financial integration, infrastructural connectivity, socialization, and unimpeded trade with cooperation under the arrangement of one framework. Furthermore, the futuristic approach of China being economic and military power will also be demonstrated. However, China is an extensive country with the largest population and military establishment. In the recent decade, it has increased the chance China to emerge as a global power. China's economy is the world rapidly growing economy and is expected to become the largest economy by 2025. In South Asia, China is one of the great civilizations of the region.

AUJOGR-21307

AUJOGR-21308

COVERAGE AND RATE ANALYSIS FOR DOWNLINK HETNETS

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RISING CHINA AS THE GLOBAL SUPER POWER: IS THE USA THREATENED?

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Abstract: The wireless based networks are continuously evolving to meet the challenges of the near future. This evolution has led to a few perturbing consequences. One of the major consequences of this evolution is increased deployment of Macro base stations to support the network which is an expensive solution and does not meet the current demand. The proposed solution to this problem is the deployment of small cells in the macro cellular network. Heterogeneous networks (HetNets) are primarily composed of macro-cells overlaid with small cells. They can potentially improve the coverage and capacity of existing cellular networks and satisfy the growing demands of data throughput. In HetNets, small cells play a key role in offloading user data traffic from congested macro-cells and extending the limited coverage of macro-cells. The difference in the transmission powers and locations of macro-cell base stations (MBS) and small-cell base stations (SBS) leads to load imbalance between these BSs in the network. This load imbalance significantly impacts the system performance and the user experience in the network is affected with varying priorities. The user association schemes determine which base station (BS) would be chosen by the mobile station (MS) to communicate in the network. Previously, three basic user association schemes have been used in the wireless networks. The user association with the BS depended on either the distance from BS, received signal strength or SINR. However, the explosion of digital devices and the scarcity of spectra collectively force us to carefully re-design new user association schemes considering the new constraints which were previously missed out. User association plays a crucial role in enhancing the load balancing, the spectrum efficiency, and the energy efficiency of networks. This research intends to propose a user association scheme that aims to balance the load in cell by sharing the load of MBSs with SBSs while maintaining better coverage and overall data rate of the network. Principles of stochastic geometry or optimization algorithms will be used to derive the required expressions.

Abstract: The rise of China can be professed either as a threat or as an opportunity for the USA, mostly depending on USA grand foreign policy interests and its related strategies. If the USA feels comfortable living in a multi-polar world in which it is considered to be an equal among the major powers, China is more likely to be perceived as a partner. However, if the goal of the USA foreign policy is to strengthen its position as the sole superpower or even as a hyper power, and does not choose to recognize other major countries, then the rise of China will be apparently as a threat. China is a revisionist power, not dissatisfied with the current order but also its position in the order. Historically, great powers have been the rule-makers of world-order to reflect their standards and interests, weak states the takers, and discontented emerging powers the breakers, following alternative principles to conform to their distinctive partialities. Based on this basic assumption, this research study seeks to examine the exact interests of the United States: Is it threatened by the rise of China or is it not certainly threatened by the rise of China? This study is based to explain the grand theories and will also examine the economic ties between the two countries. This research article will further explain the possibility of military conflict given recent events, such as the Taiwan and South China Sea disputes, in order to determine whether or not China's rise will threaten the United States interests. These questions will help me to find out to demonstration of the international arena signalling a new cold war between the two great powers, and also will helped to explore and demonstrate the shifting of alliances in the region especially in South East Asia and South Asia.

AUJOGR-21401

A SURVEY OF RECENT ADVANCEMENTS IN BIOMASS BINARY FUEL COGENERATION POWER PLANT TECHNOLOGY

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Abstract: Power plants based utilizing solid biomass or agricultural residues as a fuel are enormous in Pakistan but there are some concerns regarding their operating efficiencies. These power plants are basically operating on conventional technologies and there is no further improvements or modifications in them. So, their efficiency can be enhanced much along with little modifications or employing new techniques and methodologies to convert them to Binary fuel Cogeneration power plant or to organic Rankine cycle based combined heat and power. Like cogeneration or trigeneration can be utilized for the sake of their efficiency optimization. According to requirements and suitability, cogeneration is preferred in Pakistan. If ordinary conventional power plants are converted to cogeneration-based cycles then it will be a colossal impact regarding production, economy, and utilization. There are some power plants who are cogeneration based in Pakistan like Haveli Bahadur Shah cogeneration-based power plant.

AUJOGR-21402

PLASMA INSULIN INJECTION CONTROL SYSTEM FOR TYPE 1 DIABETES PATIENTS

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Abstract: Diabetes is a chronic disease caused by destruction in pancreatic beta cells and the pancreas is unable to produce the amount of insulin required to match excess blood sugar in the body. It is a disease which required insulin injection to normalized blood glucose level. To develop a persistent insulin control system device knowledge of control loop systems is important. In this, we are required to develop a control system that has great sensing ability to know when to inject insulin to the patient and of about what amount. The artificial pancreas, a closed-loop control system is an insulin pump connected by CGM and computer programs that would be able to detect how much hormone a patient needs has been developed. These three components of the artificial pancreas have a special objective. The insulin pump provides a continuous flow of insulin in the patient's bloodstream. CGM consists of a sensor that is attached to our skin that is monitoring glucose levels. Glucose-insulin dynamics in blood plasma are represented by Bergman minimal mathematical model. Through this model, the closed-loop transfer function of the plasma insulin injecting control system has been developed. A dedicated Operating System (OS), Dias is used as the host for the AP system. It consists of devices such as Dexcom as a glucose monitoring sensor an insulin pump. The back stepping technique is proposed to backbone the design of PID controllers. A back stepping technique is used to apply the effect controllers to blood glucose levels as there is no connection between insulin infusion and glucose level in Bergman's system model. It is usually applied to stabilize and control the state of Bergman's class of nonlinear equations. Sliding mode control (SMC) is one of the well-known powerful design tools for the problem of the deterministic control of uncertain systems since it has a significant insensitive feature to handle internal parameter variations and external disturbances has been developed.

AUJOGR-21403

THE AUTOMATIC PITCH CONTROL SYSTEM OF UNMANNED FREE SWIMMING SUBMERSIBLE VEHICLE

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Abstract: In different examination and trial regions, undersea without human mediation we need a vehicle that can achieve the necessary assignment is known as "Automated Underwater Vehicle". An automated Free-swimming sub

vehicle is to be constrained by utilizing heading and pitch control frameworks. The Complex Engineering issue is to control the UFSS vehicle by controlling pitch control frameworks and meet the ideal exhibition details. This must be accomplished by examining the system and afterward planning an appropriate regulator that meets the ideal models. The block diagram of the transfer function of subsystems is given so the initial step to dissect the framework is to lessen the block diagram to get the exchange work. Utilizing move capacities step reactions of the frameworks can without much of a stretch be controlled by numerical strategies and MATLAB. Step reactions are utilized to decide the security of the frameworks thereafter frameworks are examined in the recurrence area utilizing the Routh Hurwitz table to check if the framework meets the exhibition determinations. In this venture, we will effectively show the framework and play out the different reproduction assignments for pitch point and yaw point To make the exhibition boundaries certainly reasonable regulator (PID) should be planned. Control frameworks are a vital piece of pretty much every designing and actual framework and along these lines, their exact examination is of most extreme significance. Customarily, control frameworks are examined utilizing paper-and-pencil verification and PC recreation strategies, in any case, both of these techniques can't give precise investigation because of their inborn impediments. Model-checking has been broadly used to investigate control frameworks yet the persistent idea of their current circumstance and actual parts can't be genuinely caught by a state-progress framework in this method. To defeat these limitations, we propose to utilize Proportional-Integral-Derivative (PID).

AUTOMATIC DIRECTION CONTROL SYSTEM OF SEGWAY PERSONAL TRANSPORTER

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Abstract: Nowadays, every individual has a two-wheeler and they are using this even for reaching short distances. By these conventional resources like petrol, diesel etc, are consumed more and more. Not only the depletion of natural resources, it produces more environmental pollution hazards. To overcome this, the electric vehicle was introduced that make the life easy. But still there is one more topic that need more advancement in it, and that is the direction control system. There are already some automatic direction control systems introduced but they depends on the physical movement of the person. So there is a need of the system that controls the direction of the two wheeler without the physical movement of the rider. The main Objective of the project work is to design and implement an electrical vehicle with an acceleration and breaking functions with the feasible design which aims to control the direction of the two wheeler so that the rider would not do physical movement to control the direction of the vehicle. So we describes, design and construct a fully functional two wheeled balancing vehicle which can be used as a means of transportation for a single person. In this project we design the Automatic Direction Control system for a two wheeled personal transporter that provides a smooth and comfortable ride to the rider. Our designed system do not require the rider to lean or tilt on the vehicle to turn or control the direction. It only requires the controller input. Also our design is absolutely eco-friendly mode of transport which causes zero pollution. So it also helps to control the pollution. Its really reduces the time varying for the newly riders who drives the Segway first time. Moreover, it provides a smooth and comfortable ride and ensure safety. The final design will be based on the experiments we done on that prototype model by using various software. This project explains in detail the choice of motor, Controller, the design and the need for an electrical vehicle and its advantages.

AUJOGR-21405

AUJOGR-21406

AUTOMATIC DRUG INJECTION SYSTEM FOR HIV DRUGS: RTI AND PI

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Abstract: In this paper, an automatic injection system is specifically designed for HIV (human immunodeficiency virus) drugs also known as ARV's (antiretroviral). There are already a few automatic injection systems present but none of them meet our requirements; a system that is able to introduce ARV's in the body. The most used ARV's PI (protease inhibitors) and RTI's (reverse transcriptase inhibitors) are considered. HIV is a virus that causes the immune system of a body to fail making the body vulnerable to diseases and decreasing its life expectancy. Often life expectancy of the patient decreases exponentially. If the virus is not slowed down, it can have deadly consequences. If left untreated it can lead to AIDS (acquired immunodeficiency syndrome). It is a daily struggle for its patients. Patients of HIV have to take daily medication in order to survive. A large majority of patients have a hard time adhering to its commonly prescribed tablets which results in not only the reproduction of virus but also increase in its resistance to the regime. Injections can be the solution to this trivial. To solve these problems, long acting (LA) injectable forms.

FLOATING MOORED PLATFORM POSITION CONTROL SYSTEM WITH THRUSTERS TO MINIMIZE DRIFT AND DEVIATION

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Abstract: This project addresses the modeling and design of a moored floating system with thrusters, through which deviation and drift of the floating platform can be controlled, making the platform as much stable as possible. Such systems are applied to anchored floating production systems, wind turbines, and mobile offshore drilling units. In order to explore, survive, and produce in harsh climates innovative, reliable thinking and technology is needed. Thrust assisted position mooring is an innovative technique that is reliable and an energy-efficient station keeping method for structures that are stationed in deep water. In this design the angular deviation will be accounted for via the DC motor operated thrusters. The controller will be commanding the Thrusters only. The mooring cables will be pre-installed and will have no part in our control system. The PD controller will be used to control our system. The controller is chosen according to the requirements of system. The system designed contains large masses and disturbances. In order to minimize error and cater the disturbances, PD controller has been chosen, as it is one of the most advance and efficient controller that will stabilize the system along with improving the transient response and overshoot error. Mathematical models of floating platform mechanisms along with the thruster model has been devised. The system will also aim to make certain improvements in the present system by increasing the balancing force and net force control. Nowadays every industry aims at improving the efficiency of their work and operations irrespective of the field. The main purpose of this design will be to improve the productivity and efficiency of the mooring system that is in practice now. This design will be aiming to achieve an efficient, less complicated and productive design for Thruster assisted position mooring System.

AUTOMATIC ANESTHESIA DEPTH CONTROL SYSTEM FOR ISOFLURANE CONCENTRATION

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Abstract: The concept of Anesthesia is found from the carvings of about 2500 BC. A few decades back, the anesthesia was done manually by an anesthesiologist and the life of a patient was totally dependent on one person. So, there was a dire need to automate this system to achieve precision and accuracy and to lessen the load from the shoulders of an anesthesiologist. Feedback Control is found everywhere in Engineering World and has shaken up the protection in the fields from Car travel to the space. For everyday anesthesiologists, we give an introduction to the developed system research on field of control. This article discusses the History, Design and Working of an automatic anesthesia delivery system. It further includes the modern-day researches in the field i-e closed loop anesthesia Delivery System and Target controlled infusion. Introduction of Bispectral Index as a major indicator of Depth of Anesthesia is also a part of this article. From start of the eighties, Physicians and engineers are working in the field of the closed-loop drug delivery systems. The supply of low/high dose of anesthesia during an operation may cause adverse effects to the patient. To avoid this situation, Automatic Anesthesia control system is required that can control the amount of anesthetic provided with the reduction of human error and with high precision. The Concentration of anesthetic is controlled by Multi-task feedback system and Microcontroller chips. Closed-loop systems are able to make conclusions on their own manner. This further discusses the superiority of closed loop system over open loop system and their advantages and disadvantages. In closed-loop system, the anesthesiologist only enters the targeted value to be conserved throughout. The purpose is to make an automatic anesthesia control system for isoflurane concentration with high level of accuracy. Multi-tasking is the main characteristic for an automatic anesthesia machine and we will try to discover ways to make it cost effective, compact and easy to use. It will be easy to use with a User-Friendly Graphical User Interface and equipped with latest technology based on researches from the last decade.

AUTOMATIC SHIP ROLL CONTROL SYSTEM

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Abstract: The stability of ships is one of the most important and complex concepts related to ship safety and navigational safety and is subject to maritime laws and regulations. Ship roll always acts against the stability. Ship roll motion is a natural occurring and strongly nonlinear and multivariable dynamic phenomenon that is affected more by the disturbances in the waves. This project covers the brief concept of roll systems widely used on ships for many years. Different methods and techniques have been discussed to terminate roll. The feasibility of rolling motion control equipment has been fully proven for more than 100 years. However, due to the difficulties associated with the design of the control system, the performance still fails to meet expectations. Due to the limitation of basic performance and the large changes in the spectral characteristics of wavy rolling motion, facts prove that the design of the control system is not easy. Focus of this project will be on the key ideas that are implemented over the years with their problems faced. The accidental roll movement of surface vessels when sailing at sea can negatively affect passengers, crew, equipment, and cargo. Due to the unpredictable and irregular nature of the marine environment that causes the rolling motion, the damping of the rolling motion is a complex issue. There are several stabilization systems related to roll motion, such as gyro stabilizers, anti-roll boxes, active fins, and rudder roll stabilizers. Among all types of roll stabilizers or roll damping systems, fin roll stabilization is effective roll damping technology, but it is still the most used roll stabilizer. The stabilization has been minimized using this system while using a PID controller to overcome the errors induced during stabilization. The performance and the applicability of

mathematical models, and survey for the control methods that have been implemented and validated with full scale experiments through different methods.

AUJOGR-21409

THRUSTER CONTROL SYSTEM FOR AN UNDERWATER VEHICLE MIMICKING SQUID JET PROPULSION

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Abstract: In this research paper, we have studied a comprehensive history of the thruster control systems that have previously and contemporarily been used in the marine field. We have briefly studied some of these systems, but for our design and study purposes, we have specifically chosen the Thrust Vectored Control System. This control system is basically used for the Autonomous Underwater Vehicles and other underwater crafts including robots and submarines. In this particular control system, the vectored jet nozzle was also studied and analyzed. For the successful implementation, the main goal was to check our system for the stability and control under various scenarios. Therefore, the stability and control of system were to be checked at different inputs applied. Modern software was inculcated for the design and analysis of our Thrust Vectored Control System. And then the responses were extracted for various inputs given to the control system using advanced software techniques. Such a control system was needed to be specifically designed that would show the stable response for any given input. Therefore, if we succeed in designing such a model, it would help in implementing a real-world physical system. And this is the major advantage of designing such a control system. Next, we found the mathematical model for our desired control system. and then the required mathematical equations were found out for our specific control system of thruster. After that we have tested our designed system at different inputs for the analysis. The characteristics alongside with the behavior of the system at different inputs was checked. And the errors in the system was found and ways to decrease those errors

are also suggested. From the analysis part that was conducted, we found out the responses of our Thrust Vectored Control System. And then the results gathered for our system were analyzed comprehensively

AUJOGR-21410

MATHEMATICAL MODELING OF A LOW BYPASS TURBOFAN JET ENGINE USING HIGH FIDELITY SIMULATION TOOL

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Abstract: Gas turbine engines (GTE) are complex systems comprised of aerodynamic, turbomachinery and combustion components that are responsible for powering most aircraft flying ever since 1940s. Gas Turbines have found applications in systems requiring high power to weight output such as military and civilian jetliners, helicopters, and even in space systems. However, with these advancements and ever- increasing fidelity of the systems, the cost of testing each subsystem has risen exponentially. Thus, engine modeling and simulation have become a popular alternative and a precursor to experimental testing. The process of engine modeling in mathematical environment starts with the selection of design point of engine followed by parametric studies. The key design parameters used for performance evaluation include fan pressure ratio, compressor pressure ratio, bypass ratio, turbine inlet temperature, shaft RPM, and after-burner exit temperature. The geometry of the engine is fixed as by the conclusion of design point analysis. During the off-design analysis, the performance of engine is evaluated at different flight conditions and throttle settings for the fixed geometry. The results of these analyses may be manipulated to generate engine deck, which is a critical input in aircraft design and performance analysis. Engine deck is usually unavailable to the customers of engine manufacturing companies increasing the user's dependence on proprietary solutions.
The aim of this project is to develop a mathematical model of a low bypass turbofan engine to evaluate its performance at design and off-design conditions and validate the developed model by comparing the results with engine test bed and in-flight data. The

engine model developed in this project may be used by local aerospace industry for performance analysis of engines of similar class.

AUJOGR-21411

COMPARISON OF SUPERVISED MACHINE LEARNING ALGORITHMS FOR AIRFOIL SHAPE OPTIMIZATION

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Abstract: Airfoil shape optimization is an important part of aircraft design process. The shape of airfoil is optimized by defining objective functions based on airfoil aerodynamics and flight conditions, such as Mach number, angle of attack etc. High fidelity aerodynamic analysis tools are computationally expensive, thus making optimization process prolonged. To address this issue, machine learning (ML) models can be trained tocapture the complexity of airfoil aerodynamics with respect to its shape parameters. The trained machine learning models will be used for optimization process. To train ML algorithm, dataset is acquired having inputs and respective outputs. The number of data points in dataset may vary depending on which ML algorithm is being using. In this study, different ML algorithms will be compared based on "data points required by them to develop an accurate model". The airfoil shape optimization will be done using the trained ML algorithms, and the optimized points will be validated using aerodynamic analysis tools. This research will give an idea about ML algorithm to be used for airfoil shape optimization using minimum number of data points. Hence, it will help to reduce the time required for airfoil shape optimization process.

AUJOGR-21501

ADVANCED COMPACT POWER SYSTEM: AN OVERVIEW

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Abstract: The revived interest in micronuclear power reactors for space exploration focuses on kilowatt systems with minimum moving components such as pumps and turbines. Such reactor concepts are also likely to be attractive for micro-grids in remote populations due to their small size, mobility and safe and simple operation and maintenance. In such designs, there are a number of options on the heat removal technologies and power conversion systems. For heat removal, in a 'fast' reactor core, metal coolants such as lithium, potassium, and sodium are attractive candidates in two-phase heat pipes for operating without forced convection, while for power conversion the options include solid-state thermoelectric generation and the conventional Stirling engine. Thermoelectric generation has a direct thermal-to-electricity route with no moving parts while the Stirling engine goes through the thermal to mechanical to electrical conversion route through a crankshaft. The operating requirements of both technologies differ vastly in terms of the quality of heat, costs, efficiency, operation, and overall simplicity. For the neutronics analysis, Monte Carlo simulations can be used to establish the criticality of the design, and heat removal capability can be estimated using the empirical relations. The control and automation in a kilopower micronuclear reactor, based on the timely operation of sensors and actuators is necessary for steady state power generation. Reactor control is achieved by boron carbide layers on rotating drums in a beryllium oxide reflector surrounding the core. The control system can actuate the control drum mechanism which controls the production of heat flux to keep the power at constant level. Thus, for a coupled state-space model to determine the time-dependent response, dynamic modeling can be carried out in the MATLAB Simulink environment. This study presents a brief overview of heat-removal technologies, power conversion technologies, and control system for such a power system

AUJOGR-21502

POSITION AND FORCE ANALYSIS OF A SIT TO STAND MECHANISM FOR DISABLED INDIVIDUALS

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Abstract: Sitting and standing are the body functions commonly used in our daily life. For people with disability in lower half of the body, these essential functions become impossible to perform. Therefore, the individual with disability is always in need for assistance for their daily living tasks. In some cases, this condition is improved through therapy. In this study, a novel mechanism is proposed for independent boarding and therapy of the disabled individuals. The mechanism is intended to assist patients in motion between sitting and standing positions giving them assistance and support. The mechanism consists of parallel linkages actuated by a linear actuator. The position and force analysis of the parallel mechanism is presented in this study. The simulations result for position analysis show that the mechanism is suitable for people with disability having a height of up to 180 cm. The results for force analysis show that the actuator selected can support a patient with up to 150 Kg of weight.

AUJOGR-21503

HYDRAULIC ACTUATOR CONTROL DESIGN FOR COMPACT ENERGY SYSTEM

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Abstract: Advanced mechatronics systems used in industrial automation and energy systems have control systems based on sensors, actuators and feedback mechanism. Small scale advanced power systems which are being developed have applications in submarine vehicles, micro-grids power supply and space stations. These power systems have compact structure, high energy density and longer life which make them favorable for usage in many applications. The power systems are designed for continuous operation for a long period of time without changes in the values of output power and control parameters. The fluctuations in power of a compact energy system arise from changes in the values of system parameters. The aim is to design a control system which upon power transients actuate the mechanism which bring back the values of system parameters within desired range. Hydraulic actuator i.e. hydraulic piston along with hydraulic pump and hydraulic valves are used for this purpose. A Simulink model of energy system based on coupled differential equations was developed which determined the ranges of values of system parameters for safe and continuous operation. This model and parameters values were incorporated in SimHydraulics model of hydraulic circuit to actuate the motion of hydraulic pistons and associated mechanism for controlling the variations of parameters.

AUJOGR-21504

ANALYTICAL MODELING AND FEM ANALYSIS OF A MEMS BASED MICROGRIPPER

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Abstract: With the advancement in science, engineering, and technology systems and devices are getting smaller. Miniaturization is becoming an exciting area of interest all over the world. Miniaturization in mechatronics systems is a topic of interest in applications perspective. Actuators are always an integral part of Mechatronics systems. Actuators can be used at macro, and micro scales. Microgripper is a Microelectromechanical systems (MEMS) device used for micro manipulation. Microgripper is a device used to grip, hold, and manipulate microscale objects safely and efficiently. It has actuating, mechanical, sensing and gripping parts. Micro gripper have potential applications i.e. cell gripping, cell manipulation, cells puncturing, joining, wiring, and testing. We are designing a Microgripper with approximately 2000x2500 micrometers in size. It will be having multipurpose multiple jaws for gripping in the range of 1- 40 micrometers. Analytical modeling and Finite Element Method (FEM) based

simulations will also be done to support its design functionality.

AUJOGR-21505

OPTIMIZING IMAGE SEGMENTATION USING GENETIC ALGORITHM: A REVIEW

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Abstract: This paper describes a review of optimization techniques for image segmentation using genetic algorithm. As known to domain experts, image segmentation is a vital technique that is employed as the most fundamental part of a computer vision system to implement it in real-world scenarios. It is a complex task as there is no specific method to segment satisfactorily all the images in a generic and robust way. The image segmentation techniques depend on various parameters whose appropriate selection for successfully segmenting an image is a challenging task. This problem is formulated as an optimization problem and an evolutionary search algorithm, known as a Genetic Algorithm, is utilized to get the best possible solution in the search space of the segmentation parameter sets. In this paper, the applications of a genetic algorithm for optimizing the image segmentation parameters techniques have been reviewed.

AUJOGR-21506

THERMAL MANAGEMENT AND OPTIMIZATION TECHNIQUES IN A BUILDING USING PCM AND HEAT PIPES-A REVIEW

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Abstract: The energy demand is increasing day by day with the technology advancement and its need, almost 60% of the energy is consumed in buildings and homes it needs to reduce down the energy demand in buildings where it is possible, The idea is to build an optimized passive technique to maintain temperature (cooling/heating) of a building, which will have zero energy consumption without affecting the thermal comfort of occupants, it should be environment friendly, least possible cost, low maintenance, smart, and reliable. For this, the idea is to use passive PCM combined with heat pipes both the technologies are passive, environment-friendly, low cost and low maintenance which will play a major role in energy-saving and cost-saving, PCM have high energy storage capacity and they are used in the form of the layer in the building the combination of heat pipe will benefit to release the trapped heat inside the PCM, which will be difficult to be released by natural convention, if any active source will be used it will increase the energy requirements to run the active technology, the suggested techniques from past years research is to have a completely passive system but the system thickness, its position its placement and quantity should be optimized. Different techniques that have been used to optimize PCM including PSO, GA, and ANN are discussed and the best way optimization technique has been concluded.

AUJOGR-21601

OPTIMUM DESIGN OF A HYBRID SUSTAINABLE ENERGY SYSTEM: A CASE STUDY FOR AIR UNIVERSITY

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Abstract: Combining solar system with wind and other power sources for backup, one can have uninterrupted clean energy without relying on a single power source. Also, solar and wind does not produce destructive emissions that hurt nature as compared to conventional power sources. It's a clean sustainable and renewable process that uses the most common of the considerable number of sources: the sun and wind. This paper shows an approach to deliberately plan a hybrid sustainable power source framework for a university located at Islamabad, Pakistan. Which comprises of sun based, wind and diesel generator as a substitute asset and a storage battery, from the starter

configuration stage to the ideal operation stage. The programming software utilize for the analysis of this sustainable system is HOMER Pro 3.2.3. The investigation of sustainable source frameworks arrangement delivering AC load of 415.81 kWh/day power utilization having a 17.33 kW peak load. The output of simulation expose that optimized size of parts, sun powered (1 kW) - Wind turbine (3 kW) - diesel generator (125 kVA) and improved cost of power around 0.23 $/kWh.

AUJOGR-21602

OPTIMIZED SYSTEM PLANNING FOR DRONE-DELIVERY OF RELIEF PACKAGES IN DISASTER-HIT AREAS

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Abstract: Drones have found numerous usages in recent times in applications including search and rescue, monitoring international borders, sports events coverage and parcel delivery. Other useful applications include delivery of relief items to the in-accessible disaster-hit areas. Usually a disaster-hit area is large and affected locations can be anywhere within the area. Flight distance of the drones is limited due to the battery capacity constraint. There is a need to install charging stations so that the drone can charge/replace its battery when it runs out of power. The charging stations should be transported using road infrastructure and pre-installed in the disaster-prone area, as access may be denied once it is hit with disaster. In this article we have presented an optimization model for drone-delivery of relief items to the disaster-hit locations using a fleet of drones. The objective of the model is to optimize the number of charging stations and the total distance travelled by drones to serve the disaster-hit locations. We have implemented the relative priority in which preference has been given to the locations of higher priority level. Optimal number of charging stations and optimal routes have been found for different sizes of the disaster-hit area.

AUJOGR-21603

SECURE EMBEDDING OF PATIENT INFO INTO BRAIN MRI IMAGE USING HYBRID SPATIAL AND DCT DOMAIN CRYPTO-STEGANOGRAPHY

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Abstract: Due to recent advancements in Internet of Things IOT and use of wireless transmission methods in healthcare applications, secure transmission of the patient's data has become a big challenge. Various techniques of Cryptography and Steganography have been developed for this purpose. In this research article we propose a novel technique to transmit patient's secret diagnosis information regarding brain MRI. The textual diagnostic report is taken as an image, called as message image, and is hidden in MRI of that patient. In the proposed scheme, the MRI image, used as a cover image, is divided into blocks, termed as poxels. Nearly half of the poxels, selected by a secret chaotic key sequence, are converted to Discrete Cosine Transform domain leaving the remaining in spatial domain. Information, after passing through RSA encryption scheme, is embedded into the poxels, using least significant bits replacement method, in such a way that poxels in transform domain carry a major portion of information. For secrecy enhancement, another secret chaotic key sequence is employed to select pixels for embedding data in spatial domain poxels. To further enhance secrecy level of the system, an algorithm is developed to determine the region, within a transform domain poxel, to carry the information and the position of that region is kept secret. At the receiver side, message image is successfully retrieved. Results prove that the proposed methodology promises improved performance parameters such as peak signal-to-noise ratio (PSNR), mean square error (MSE), and structural content (SC).

AUJOGR-21604

CONVOLUTIONAL NEURAL NETWORK BASED TIME-VARYING REACTIVE POWER FORECAST MODEL

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Abstract: Reactive power is a very crucial element in the power system, to fulfill the requirement of reactive power capacitor banks are used but their amount is limited to the capacitor size in the distribution network. To achieve optimal power flow and to minimize power losses and capacitor switching, there is a need to predict the reactive power. Excessive reactive power transmission leads to higher line losses and the lack of reactive power transmission can lead to voltage problems like under-voltage and even risk of voltage collapse. The forecasting of real power fulfills the requirement of supply-demand balance while the forecasting of reactive power provides efficient management of reactive power resources. Convolutional Neural Network (CNN) has been suggested in this paper for forecasting reactive power and the result can be used for planning, system expansion, and investment planning.

AUJOGR-21605

FLUORESCENT CONCENTRATOR FOR WIDE FIELD OF VIEW IN VISIBLE LIGHT COMMUNICATION

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Abstract: The world is going towards technology, mobile users and internet users are rapidly growing day by day and there is a demand of high-speed and efficient internet without interruption. Now, everyone is looking on a new emerging wireless technology Visible Light Communication (VLC) because of its high speed, better bandwidth, and its security point of view. For VLC, signal to noise ratio (SNR) of a channel can be increased by increasing the area of a receiver that receives the light. The traditional techniques for increasing the received signal and signal to noise ratio (SNR) are the usage of optical concentrators. The optical concentrators such as parabolic and compound parabolic concentrators limit the field of view. After considering the above problem, a fluorescent concentrator is a good solution for wide field of view. The dimension used for fluorescent concentrator is 75mm x 25mm x 1mm. The light sources tested are LED matrices, reflectors, reflectors with lens and laser module. The transmitting and receiving problems were discussed in this paper and proposed a solution and applications of the new emerging technology VLC were also discussed.

AUJOGR-21606

HYBRID SOLAR-SPEED BREAKER BASED ENERGY SYSTEM

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Abstract: Hybrid Solar-Speed Breaker-based energy system provides the customers (consumers) with the benefits of green as well as the free of cost energy. This research work uses two non-conventional energy sources (renewable energy sources) to generate green as well as economical friendly electricity. In this proposes research work both of the non-conventional energy sources have been controlled by using the PI controller. Here the purpose of the PI controller is to remove the steady-state error as well as to enhance the response of the system, here the important thing to be noted out is that the PI controller does all of the above tasks without disturbing the stability of the whole system. In the proposed work the PI controller has been embedded with the DC-DC converter in such a way that it does work based on an error signal, by using this error signal as input it does stabilize the whole system by enhancing its response. There may be a mismatch of voltages in both of the sources being used in the proposed work. The prime objective of the proposed mechanism is to make sure the continuous supply of power to the consumers. According to the proposed work, one source transfers the power to the output during a time when the other source is not capable of transferring the power to the output, thus the continuous supply of the energy to the consumers can make sure by

hybridizing the two non-conventional energy sources.

AUJOGR-21607

AN ATLAS-FREE AUTOMATIC NEONATAL BRAIN MR IMAGE SEGMENTATION

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Abstract: Detailed morphometric analysis of the neonatal brain is required to characterize normal brain development and investigate the neuroanatomical correlates of cognitive impairments. The segmentation of the brain in Magnetic Resonance Imaging (MRI) is a prerequisite to obtain quantitative measurements of regional brain structures. These measurements obtained at term equivalent or early preterm age may lead to improved understanding of brain growth and may help evaluate long-term neurodevelopmental performance at an early stage. This synopsis focuses on the idea of developing an accurate segmentation algorithm for the neonatal brain MR images and its application in large cohorts of subjects. Neonatal brain segmentation is challenging due to the large anatomical variability as a result of the rapid brain development in the neonatal period. The lack of training data in the neonatal period, further hinders the development of automatic segmentation tools. A novel algorithm for the tissue segmentation of the neonatal brain is proposed. The algorithm is extended for the regional brain segmentation.

AUJOGR-21608

FAULT TOLERANT CONTROL FOR MICROGRID WITH ENERGY MANAGEMENT

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Abstract: The goal of this work is to propose a low cost and efficient voltage-source topology and its implementation with variable-speed wind energy conversion system (VS-WECS). The suggested topology consists of an inverted buck-boost converter whose ac side connected to a direct-drive permanent-magnet synchronous generator (DD-PMSG) and the dc side is connected with the inverter module. This research presents a space-vector pulse width modulation (SV-PWM) technique for the inverter module. Reducing switches to six only in the inverter module and the most significant minimization of total harmonic distortion (THD) at the output are achieved parallel to the traditional sinusoidal pulse width modulation (S-PWM) method. Besides, maximum power-point-tracking (MPPT) control algorithms are applied to capture maximum power from variable velocities of wind. The operational principle of the proposed converter with WECS is explained in detail. MATLAB-Simulink software is used to analyze and verify control results.

AUJOGR-21609

ANALYSIS OF WIND ENERGY CONVERSION SYSTEM WITH AC-TO-AC CONVERTER TOPOLOGY

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Abstract: The goal of this work is to propose a low cost and efficient voltage-source topology and its implementation with variable-speed wind energy conversion system (VS-WECS). The suggested topology consists of an inverted buck-boost converter whose ac side connected to a direct-drive permanent-magnet synchronous generator (DD-PMSG) and the dc side is connected with the inverter module. This research presents a space-vector pulse width modulation (SV-PWM) technique for the inverter module. Reducing switches to six only in the inverter module and the most significant minimization of total harmonic distortion (THD) at the output are achieved

parallel to the traditional sinusoidal pulse width modulation (S-PWM) method. Besides, maximum power-point-tracking (MPPT) control algorithms are applied to capture maximum power from variable velocities of wind. The operational principle of the proposed converter with WECS is explained in detail. MATLAB-Simulink software is used to analyze and verify control results

AUJOGR-21701

GIS BASED COVID-19 PREDICTION SYSTEM

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Abstract: The fatal disease of Covid-19 is wrapping up the whole world community. There are almost 30 million infected people and nearly 535K deaths in the U.S. which has the highest number of cases as compared to all other countries. Short-term predicting models are designed to predict possible events. This system has been made to predict the overall behavior of COVID-19 in a particular area with a geographic information system. The idea is that if a system predicts the penalty of the worst scenario or average scenario of a specific geographic location, a considerable decision could be taken before to control the overall disaster. The system could suggest the important needed actions according to the prediction in a particular location. The system is taking prediction with well-powered machine learning algorithms and a comparison between them. Three evaluation metrics are used in the study such as mean squared error (MSE), root mean square error (RMSE), and mean absolute error MAE to judge the performance of each machine learning model. It observed that the random forest prediction much better than linear regression in the case of the covid-19 scenario. It is hoped that this system will help the community to get them safe in case of an alert situation related to their actual location.

AUJOGR-21702

ELECTRONIC TOLL COLLECTION AND RECORD MANAGEMENT SYSTEM

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Abstract: In this modern era, the cities are connected through well maintained network of roads. In order to keep those roads up to the mark all the time, funds are required, which are generated by the vehicles that use those roads. For this purpose, toll booths are installed at various locations on the roads. In Pakistan, most of the toll booths are working manually, which frequently cause traffic Jam. In this paper, we propose an Electronic toll collection system along with the vehicle record management system. With the implementation of the proposed system, the risk of traffic jam can be reduced, and smooth flow of traffic can be possible. Beside, electronic toll collection system, the vehicle record management system can help in case of an emergency or theft. For instance, if a theft happened through a vehicle which crossed the toll booth, then vehicle can be tracked by inspecting vehicle number and its record can be retrieved, that at what time the vehicle has crossed the toll booth. Hence, the proposed system can help in curbing the theft to some extent

AUJOGR-21801

NAVIGATING POLITICS OF BLACK MARGINALIZATION: A CRITICAL REFLECTION OF THE GUARDIAN BY JOHN GRISHAM

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Abstract: The incidents of race or racial discrimination is still a part of the advanced and the so-called twenty-first-century America. It not only affects America's society but also greatly influences the third world countries due to the colonial approach by the British and America. Due

to this discrimination, hundreds of Blacks in the US have been disappeared or prisoned for the crimes they have not committed. The same sort of inequality can be seen in Pakistan due to the discrimination and prejudice by the Pakistani government and militants. Especially the tribal areas of Pakistan have been facing the worst in such situations. Thousands of people have been disappeared since 9/11 due to the adulterous approach by the government and military. The article is an approach to show the still racist view or Black marginalization, on the paradigm of racism, in the novel "The Guardian" written by John Grisham. Also, it will enlighten the readers about Pakistan's military and government approach towards discrimination which creates great chaos in the country nowadays. The research will be qualitative and will use Critical Race Theory by Delgado and Steffencic for analysis.

TITLE OF PAPER IN TIMES NEW ROMAN BOLD 14PT MAXIMUM WORD LENGTH 15 WITHOUT ABBREVIATIONS

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Abstract

This paper is written in MS Word for Windows and will be uploaded in PDF form. Figures should appear in running text. Photographs should be avoided. The uploaded PDF should not be larger than 10 MB. Abstract is in Times New Roman 10 pt. Please be concise and state clearly the Objectives, Methods, Results, Conclusions and how this work furthers research in this area. A typical Abstract should be between 250-300 words. Paper 5 - 10 pages. There should be no references cited in the Abstract so that it can stand alone in a Book of Abstracts. The Abstract is in Times New Roman 10 pt. Please be concise and state clearly the Objectives, Methods, Results, Conclusions and how this work furthers research in this area. A typical Abstract should be between 250-300 words. There should be no references cited in the Abstract so that it can stand alone in a Book of Abstracts. A typical Abstract should be between 250-300 words. There should be no references cited in the Abstract so that it can stand alone in a Book of Abstracts. Keywords 3-5 separated by semicolons ending with a full stop.

Keywords: energy; solar; photovoltaic; baseload.

1. INTRODUCTION

This is in Times New Roman 10pt. References are to be cited in brackets. You can download Mendeley and go to References in Word MS then click on "Insert Citation" and look for the Author or key words to find the reference. Then click in "Insert Bibliography" and the reference will be automatically added to your References section. Within the text, cite your references in numerical order in [brackets] according to their appearance in your paper. Use the IEEE Style. Wikipedia references are not allowed to be cited in the paper. References on Energy [1], [2] are cited like this. Then you can have for example three references on solar energy [3]–[5]. For two references on nuclear energy, cite them like this [6], [7]. The number of references should be no more than 20.

This paper is organized as follows: The underlying theory is presented in Sec. 2. Key issues, status and opportunities of energy technologies are discussed in Sec. 3 with a focus on financial issues. The detailed plant commissioning efforts required are discussed in Sec. 4. Finally, conclusions regarding overall viability are presented in Sec. 5.

2. THEORY

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[1] *Corresponding author name and institution email and personal email*

Begin new section like the previous section and a sub-section like this.

2.1 Second level heading Begin a sub-section on the same line but bold title.

2.2.1 <u>Third level heading</u>: This does not need to be a bold heading and continue on the same line/

3. MODELING AND SIMULATION

Equations should be put in Tables with no borders, three columns width 10%, 80% 10% with the equation number appearing in the right column as follows:

$$F = ma \hspace{6cm} (1)$$

Equation (1) is Newton's second law of motion. When beginning a sentence, use the full word "Equation(1)" to refer to an equation but inside a sentence, refer to it as "Eq.(1)" without the quotes. Use SI units throughout the paper. Tables and figures should be formatted as follows, with captions in running text placed close to their mention.

Table 1. List of solar plants.

Name	Type	Power (MW)
ABC	PV	100
DEF	CSP	100

Figures should fit into one column or can extend to both. The axes and labels should be large enough to be clearly readable.

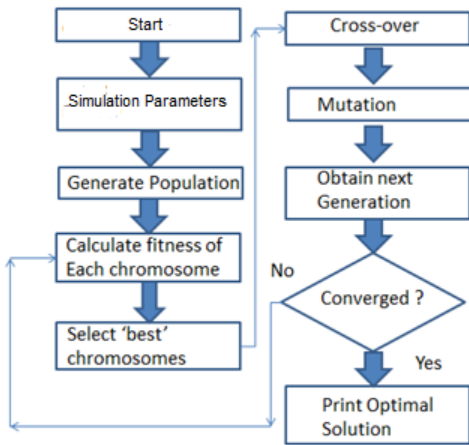Fig.1. The GA algorithm.

4. RESULTS

5. CONCLUSIONS

NOMENCLATURE

Capital

A   means this
P   power
T   temperature

Lowercase letters

Greek capital symbols

Γ current
Δ change

Greek lower case

α absorptivity

Subscripts

Superscripts

Abbreviations

MW   megawatt electric

ACKNOWLEDGEMENTS

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