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Green Electrical Energy Production by Porous Oxide Based Hydroelectric Cells

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Statement of the Problem: Porous ceramic materials are widely used in both research and commercial fields for many applications. It is known that oxide based porous ceramic humidity sensors give the better response than polymer-based sensors due to their extensive properties like high tensile strength, good thermal capacity, and high environmental and chemical stability [1, 2]. The advantage of a porous oxide ceramic is that water molecules and vapor can simply pass through the pore openings and capillary condensation takes place in the capillary porous structures which were produced between the grains in ceramics [8], resulted in more effective surface area. Humidity sensors based on the porous ceramics are working on the principle of water adsorption on surface followed by dissociation. Water can be adsorbed in two forms on the surface of oxides; (a) chemical adsorption in the form of hydroxyl groups (chemisorption) and (b) physical adsorption (physisorption). On the basis of the working principle of porous oxide humidity sensors, a device was proposed which can produce electricity known by hydroelectric cell (HEC) [3, 4]. So, HEC is one of the sources of green electrical energy which uses only few drops of water to produce electricity without any harmful effects to the environment [5]. The pictorial presentation of chemical reactions, which take place due to adsorption and dissociation at defect sites and HEC, are shown in Figure 1.

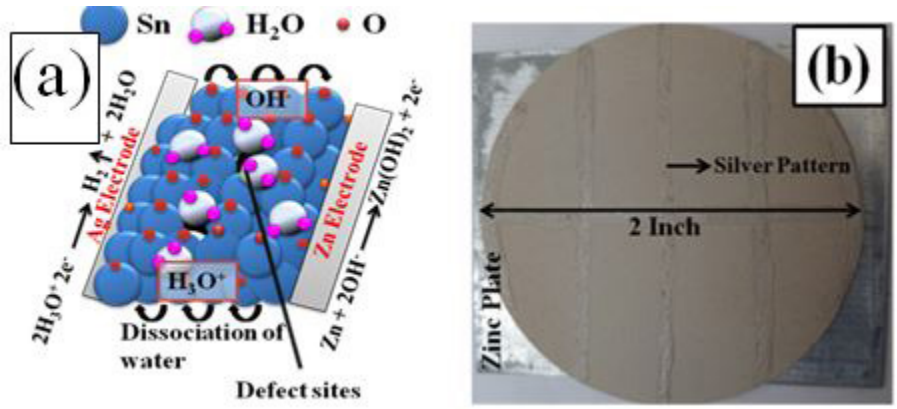
Methodology & Theoretical Orientation: Analytical grade precursor powders of SnO2 (CDH Ltd., Purity 99.5%) and Li2CO3 were used as starting materials. The precursors were mixed in stoichiometric amount and then ground thoroughly in a pestle mortar for 1 hour followed by pre sintered at 600 °C for 4 hrs for the preparation of pure, 5 Mol %, 10 Mol %, 15 Mol % and 20 Mol % Li Doped SnO2 samples. After that Pre-sintered powder was again ground for 4 hrs by dry as well as wet grinding in acetone and pressed into 2-inch (for hydroelectric characterizations) and 1 cm diameter (for electrical characterizations) pellets using hydraulic press. These pellets were annealed for 5 hrs at 700 °C to obtain required strength and porous nanostructure.

Findings: It is observed that the current generated in 15 mol% Li doped SnO2 HEC reduced to 11 mA from 71 mA in 2 hrs. Decrease in current may be attributed to concentration loss and oxidation of zinc electrode. There is a big challenge to rectify these two problems for more efficient HECs. The voltage for all the samples remains in the range 0.92 V to 0.75 V for 2 hrs since it dependents on the reaction potential of external electrodes only. Obtained hydroelectric current, voltage values in Li doped samples is more sustainable than earlier reports for SnO2, Al2O3, ZnO, TiO2, MgO and SiO2 samples.

Conclusion & Significance: Pristine and lithium doped SnO2 based hydroelectric cells were synthesized by solid state sintering method. Environment friendly and sustainable power generation have been achieved successfully. Voltage and current generation were investigated in detail for each sample. Maximum power about 71.8 mW was observed for 15 mol% Li doped SnO2 sample. Dielectric and J-E characteristics of samples without water (dry)

and with water (wet) confirmed the adsorption and dissociation of water molecules in samples. Eventually, we can conclude that porous ceramic SnO2 based HECs are promising candidate for green electrical energy source.

Figure 1: A pictorial presentation of (a) adsorption of water molecules on the surface of SnO2 sample and (b) actual image of prepared Hydroelectric Cell.



Biography

Dr. Vivek Kumar Verma has completed his B.Sc. and M.Sc. from University of Lucknow, India. He has done his PhD in Physics at the age of 29 years from University of Delhi and National Physical Laboratory (CSIR), Delhi, India. In 2009 he has joined Department of Physics, Hindu College, University of Delhi as an Assistant Professor. Dr. Vivek Kumar Verma is lifetime member of Magnetic Society of India. He has supervised many Ph.D. students. His area of interest are nano magnetic materials, EMI shielding, ferroelectric materials and energy materials. He has published more than 50 papers in reputed journals and serving as an active member of scientific society.