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Photoferroic ($ZnSnO_3$) for photovoltaic applications

Manikandan Marimuthu[1] and **Mukilraj Thayanithi**[2]
[1]Anna University, India
[2]University of Madras, India

In the recent decades, the field of renewable clean energy i.e., solar energy has emerged as an alternative to the traditional power sources. Solar energy is one of the most important resources which have been harvested through Photovoltaic (PV) effect. Photovoltaic effect typically involves two basic processes: generation of electron-hole pairs as and separation of electrons and holes. In semiconductor based solar cell, the generation and separation of electrons and holes usually takes place at a material interface and the maximum open-circuit voltage is equal to the semiconductor band gap. Since there is observation of bulk photovoltaic effect in the ferroelectric materials, the open-circuit voltages exceeds the band gap due to the separation of electron-hole pairs by the built-in potential induced by intrinsic polarization. The bulk photovoltaic effect has been reported in several ferroelectric perovskite oxides, such as $Pb(Zr,Ti)O_3$, $BaTiO_3$ and $LiNbO_3$ family. These oxides have relatively large internal electric fields that could be exploited in photovoltaic applications. Hence, harvesting solar energy from ferroelectrics is still a new field of research and which grew considerable attention in the recent years. Therefore, the $LiNbO_3$ type $ZnSnO_3$ is prepared by hydrothermal method. The prepared $ZnSnO_3$ is explored as photoanode in the solar device and the device performance is tested using I-V characteristics. The photo-physical properties are analyzed and explained using appropriate mechanisms. X-ray diffraction confirms the R3C symmetry of polar $ZnSnO_3$ phase. Scanning electron micrograph shows an agglomeration of square shaped particles. Ferroelectric behaviour is confirmed by P-E loop tracer. Double semicircle, one in the low frequency and other in the relatively high frequency explains the charge transport characteristics between the interfaces of the fabricated device. An open circuit voltage of 0.64 V, a short circuit current density of 1.39 mA/cm^2 and a conversion efficiency of 0.5% are obtained for the constructed device. These results show the potential value of ferroelectric $ZnSnO_3$ for use in solar cells, although the efficiency cannot yet compete with semiconductor materials. An effort is hence put forth for the deep understanding on photovoltaic mechanisms in ferroelectric materials.

mani7289@gmail.com