Graduate Physics Seminar
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University of Nova Gorica - Ajdovščina Campus
Vipavska 11, Ajdovščina
Amphitheatre

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# ZnO nanostructures, synthesis and applications

**Abstract**

I will present methods to fabricate, test and characterize ZnO nanorod-based energy harvesters and the impact of surface passivation of the ZnO on power output for a vibrational harvesting system and a photovoltaic. Previous studies have focused on improving the performance of these devices. In this regard, suppression of semiconductor carrier screening and improvement in device architecture had been reported. However, the impact of ZnO nanorod passivation on p-n junction devices has not been studied.

The first section of the presentation will discuss the passivation of ZnO nanorods using CuSCN in ZnO/PEDOT:PSS (poly(3,4 ethylenedioxythiophene) poly(styrene-sulfonate)) p-n junction-type piezoelectric energy harvesting devices. The maximum power density across its optimal load is determined by testing the device across variable resistors showing higher output from passivated devices. The increase in voltage and voltage-driven current is discussed with relation to changes in the carrier lifetime. A comparison between passivated and non-passivated ZnO devices shows that the passivated device generated an open-circuit voltage of 212 mV and short circuit current of 1 mA/cm2 which was around twice the value of non-passivated device (90 mV and 0.66 mA/cm2). When tested across a range of load resistances, the maximum power density was also found to have almost doubled from 36.00 $\mu$W/cm2 across a 1.38 k$\Omega$ load for the non-passivated device to 64.40 $\mu$W/cm2 (1.67 k$\Omega$) for the passivated device. We deduce that the voltage and voltage-driven current density of the passivated ZnO device improved due to three-fold increase in carrier life time.

The second part of the presentation will focus on the photovoltaic (PV) effect of perovskite materials and methods of passivating the surface of ZnO to enable thin film growth. I will report on the design, fabrication and testing of a solid-state perovskite enhanced ZnO solar cell. The p-type perovskite material used was bismuth ferrite (BFO), so far not implemented in a ZnO solar cells. The cell uses FTO and Au electrodes sandwiching semiconductor layers and a CuSCN hole conductor, the ZnO was sensitized with N719. XRD confirmed the presence of BFO with the presence of a single [110] BFO peak. The results show a significant increase in the performance with efficiencies increased by almost 3 times with the BFO coating with an efficiency of 0.272%. The BFO acts as a buffer from electron recombination. However, the relative increase in performance of the solar cell when BFO was added shows promise of BFO as a PV material.

In summary I will show that there are a range of energy harvesting devices that can be produced using a surface passivation layer on a ZnO nanorod architecture and that by careful control of the process parameters enhanced energy harvesting is possible.