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Fabrication and Characterization of Germanium Doped Titanium Dioxide (Ge:TiO_2)T hin Film for Photovoltaic Application

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This study intends to realize a novel thin film material for photovoltaic applications. TiO_2 that has a large band gap of 3.2eV is sensitized to visible light via the use of dyes in the Gratzel cell. The dye monolayer when excited by light photons, electron-hole pairs are generated, electrons are injected into the conduction band of TiO_2, while the holes are transported to the counter electrode by diffusion. The use of dye and wet electrolyte material has associated instability problems which threatens the suitability of this type of solar cell for commercialization purposes.

The objective of this proposed study is to come up with a semiconductor material of a smaller band-gap which can be used to fabricate a solar cell. This is to be achieved by doping the metal oxide (TiO_2) with germanium utilizing the property of the semiconductor nanodot band gap variation with the size. The reduction of the band gap is expected to broaden the wavelength range of the incident light that can be absorbed by the material. This involves the use of large band gap materials (TiO_2,) in the form of a thin film that acts as the matrix within which atoms of Ge are added by doping. This enables the tailoring of the band gap of the matrix semiconductor (TiO_2,) to absorb incident radiation of a wide range of wavelengths. Film deposition will be done using the sputtering method. Substrate temperatures will be varied for deposition in order to vary the phase. Annealing of the deposited films will be done at different temperatures. The films will then be investigated using various techniques to establish their structural, optical, electrical and opto-electrical properties. The results of the investigation will help to optimize the material performance for fabrication of the solar cells of high efficiency and low cost.