Effects of TiCl4 Surface Passivation on the Performance of Dye-Sensitized Solar Cells

Kamal Prajapat1, Mahesh Dhonde1,\*, Kirti Sahu2, and VVS Murty3

1Department of Physics, Medi-Caps University, Indore, 453331, M.P., India

2Department of Physics, S.N.G.P.G. College, Khandwa, 450001, M.P., India

3Department of Physics, Govt. Holkar Science College, Indore, 452001, M.P., India

[maheshdhonde86@gmail.com](mailto:maheshdhonde86@gmail.com)

**Abstract**. Dye-sensitized solar cells (DSSCs) have emerged as a promising alternative to conventional silicon-based solar cells due to their low cost and high efficiency. However, one of the major challenges in the development of DSSCs is their susceptibility to recombination losses, which can significantly reduce their efficiency[1,2]. Surface passivation is a key approach to address this issue by reducing the density of surface states and enhancing charge separation[3–5]. This study focuses on the role of surface passivation in DSSCs, which involves the use of TiCl4 in different concentrations (10-30 mM) over the mesoporous TiO2 layer to reduce surface recombination. Based on our research, we found that optimizing the concentration of TiCl4 to 20 mM considerably enhanced the structural, optical, and electrical properties of the TiO2 photoanodes, leading to greater light-harvesting and overall power conversion efficiency in the pertinent DSSC.

References:

[1] Park J H, Kim J Y, Kim J H, Choi C J, Kim H, Sung Y E and Ahn K S 2011 Enhanced efficiency of dye-sensitized solar cells through TiCl4-treated, nanoporous-layer-covered TiO2 nanotube arrays *J Power Sources* **196** 8904–8

[2] Charoensirithavorn P, Ogomi Y, Sagawa T, Hayase S and Yoshikawa S 2010 Improvement of Dye-Sensitized Solar Cell Through TiCl4-Treated TiO2 Nanotube Arrays *J Electrochem Soc* **157** B354

[3] Manthina V and Agrios A G 2016 Blocking layers for nanocomposite photoanodes in dye sensitized solar cells: Comparison of atomic layer deposition and TiCl4 treatment *Thin Solid Films* **598** 54–9

[4] Vasanth A, Powar N S, Krishnan D, Nair S v. and Shanmugam M 2020 Electrophoretic graphene oxide surface passivation on titanium dioxide for dye sensitized solar cell application *Journal of Science: Advanced Materials and Devices* **5** 316–21

[5] Tehare K K, Navale S T, Stadler F J, He Z, Yang H, Xiong X, Liu X and Mane R S 2018 Enhanced DSSCs performance of TiO2 nanostructure by surface passivation layers *Mater Res Bull* **99** 491–5