**Link:** <https://solar-power-tech.com/e-posters/dsc_eposter_11/>

**Abstract**

Global warming is among the most severe climate changes caused by humanity’s irresponsible economy. It is essential to look for new solutions to overcome the issue mentioned above, such as reducing the utilization of fossil fuels. Here, renewable energy sources like solar cells deserve our attention. Since 1991, when O’Regan and Grätzel have invented dye-sensitized solar cells (DSSC), scientists worldwide are still researching this field [1]. This breakthrough was a milestone in the photovoltaic research area. Today, despite the DSSC not outperform commonly used silicon solar cells or perovskite solar cells photon-to-electron conversion performance, these devices should still be developed due to their range of advantages. DSSC consists mainly of three elements: photoanode (made by semiconductor layer sensitized with dye), electrolyte (redox mediator provides electron exchange during operation of a cell), and counter electrode (acceptor of electrons from external circuit providing dye’s regeneration via catalysis of reduction of redox species in the electrolyte) [2]. This type of solar cell is typically made of low-cost and eco-friendly materials (e.g., titanium dioxide, natural dyes). Moreover, compared to silicon and perovskite solar cells, DSSC can work after intercepting the first incident photon of light. Therefore, DSSC can also be utilized in the “Internet of Things” (IoT) concept, which assumes the creation of autonomous devices or applications controlled by the Internet. Such IoT devices will be mainly used in our houses or offices. Thus DSSC, which can efficiently convert indoor light into electricity, can be attached to mentioned above devices and power them. Recently, Freitag and co-workers showed that DSSC outperformed the GaAs solar cells under 1000 lux indoor illumination, proving that they can be utilized in this area [3].

This work presents a series of pure and Zr4+ doped-TiO2 nanomaterials with different Zr4+ ions content, synthesized by the simple sol-gel method [4]. Nanomaterials (nanopowders and films scratched off FTO substrate) were investigated in detail by XRD, Raman, TEM, SEM, EDS, TGA, FTIR, DRS, N2 adsorption-desorption isotherms, XPS, UPS, and EPR techniques. The introduction of Zr4+ ions into TiO2 lattice caused inhibition of anatase to rutile phase transformation and formation of defects. Despite that, the doped-TiO2 bandgap broadened, overall photoconversion efficiency of assembled DSSC was increased in the case of 3.7% content of Zr4+ ions. Enhancement of photon-to-electron conversion performance up to 8.63% value was recorded for the first time for DSSCs based on Zr4+-doped TiO2. Determination of photoelectrochemical parameters was performed using the I-V characteristic, as well as EIS and IPCE analytical methods. The role of Zr4+ ions were also elucidated by theoretical calculations using density functional theory with Hubbard correction.