INVESTIGATION OF CHARGE TRANSPORT KINETICS IN PEROVSKITE SOLAR CELLS USING THE KINETIC PHOTOCONDUCTIVITY METHOD

Dovilė Vasiliauskaitė[1], Lauryna M. Svirskaitė[2], Ernestas Kasparavičius[1], Vidmantas Gulbinas[1]

[1]Center for Physical Sciences and Technology, Department of Molecular Compounds Physics, Lithuania
[2]Kaunas University of Technology, Faculty of Chemical Technology, Department of Organic Chemistry, Lithuania
dovile.vasiliauskaite@ftmc.lt

Renewable energy sources such as wind and solar energy have proven to be the cheapest and effective electrical power generation methods [1]. Alongside the ever increasing global power demand, further improvement and development of new technologies for power generation, such as organic and inorganic photovoltaics (PV), are highly incentivised. One example of rapidly developing PV technology field are the perovskite solar cells (PSCs). In less than two decades time, power conversion efficiency (PCE), value used to best describe the efficiency of solar cells, of PSCs improved from 3.8% to 27.2% [2,3]. This fast approach of the Shockley-Queisser limit in perovskite solar cells is significantly attributed to the development of new effective charge transport layers, as well as the tuning of the perovskite composition and structure, thus a better understanding of charge generation and transport kinetics is crucial for the further development and future applications of PSC photovoltaic technologies.

In this work the effect of different charge transport layers (CTLs) on the kinetics of charge extraction in modified perovskite solar cells is investigated using the kinetic photoconductivity method. The performed measurements showed that different materials used as charge transport layers significantly affected charge extraction kinetics. Comparison of charge transport kinetics of novel CTLs with good performing conventional materials like SnO2 and MeO-2PACz allowed to indirectly evaluate the work-functions and band bending in the semiconductor systems as well as the overall performance of the solar cells.

Based on the obtained kinetic data, schematic depictions of band bending profiles were created for each investigated CTL, enabling the assessment of their performance as charge transport layers in solar cells.

Keywords: Perovskite solar cell, charge transport, kinetic photoconductivity method

[1] G. R. Timilsina, “Are renewable energy technologies cost competitive for electricity generation?,” Renewable Energy, vol. 180, pp. 658–672, Sep. 2021
[2] A. Kojima, K. Teshima, Y. Shirai, and T. Miyasaka, “Organometal halide perovskites as Visible-Light sensitizers for photovoltaic cells,” Journal of the American Chemical Society, vol. 131, no. 17, pp. 6050–6051, Apr. 2009
[3] C. Tian et al., “Photostable donor–acceptor interface for minimizing energy loss in inverted perovskite solar cells,” Nature Photonics, Jan. 2026