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MATERIALS SCIENCE AND ENGINEERING

Belgrade, December 1-3, 2021

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Application of supercritical carbon dioxide for making perovskite photodiode

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Perovskite solar cells reached high efficiency in a short period. When perovskite was applied for the first time as photovoltaics, power conversion efficiency (PCE) was less than 3 %. Up to now, PCE is over 29 %. In perovskite solar cells, the perovskite layer is an active layer that absorbs the visible part of the spectrum. To reduce the recombination of charge carriers, the construction of solar cells requires the existence of layers for holes and electrons. TiO_2 is usually used as an inorganic electron transport layer because its conduction band (CB) lies under the CB of perovskite, so electrons could diffuse from CB of perovskite to CB of TiO_2. For these experiments, TiO_2 nanotubular structure was used due to its advantages compared to nanoparticular TiO_2. TiO_2 nanotubes provide a one-dimensional transmission channel for the charge carriers which will reduce the recombination of the carriers and provide a fast carrier transport. The TiO_2 nanotubes were synthesized by anodization of Ti foil after which they were annealed at 450 °C for 1 h. Their inner diameter was ~ 103 ± 17 nm while the length was ~ 350 nm. Methylammonium lead bromide perovskite ($MAPbBr_3$) was deposited on TiO_2 nanotubes from the solution in dimethylformamide (DMF) by application of supercritical carbon dioxide at 35 °C and different pressures (100, 200, and 300 bar). It has been observed that supercritical CO_2 improves the filling of nanotubes by the perovskite due to its stronger solubilizing power at higher pressures. A perovskite photodiode with an improved contact surface between TiO_2 and perovskite was made, which is the basis for future solar cell construction. I-V characteristics show that the highest value of photocurrent under visible light reached 400 μA for the sample which was obtained at 35 ° C and 300 bar for 1 h. The absorption edge of prepared TiO_2 nanotubes/$MAPbBr_3$, determined by diffuse reflectance spectroscopy, was extended to the visible range. FESEM and XRD analyses also were done.