INFLUENCE OF Cu OXIDES AND PEDOT ON THE PHOTOACTIVITY OF NANOPOROUS TiO_2

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Known for its low toxicity, good photostability and high photoelectrochemical activity under UV illumination, (nanostructured) titanium dioxide is a popular material for solar cells, electrochromic devices, sensors, and various photocatalytic applications. One of the limitations regarding the use of TiO_2 in this area is the fact that its photoactivity under visible light illumination is very low, due to a wide band-gap. This, combined with the low percentage of UV irradiation in the light that reaches Earth, motivated scientists to search for ways of widening or moving the photoactivity window of TiO_2 towards visible light. Some of the ways of doing that include ion doping, sensitization with organic molecules, or creating heterojunctions with other semiconductors with smaller band-gaps [1,2]. This report describes how the addition of PEDOT (poly(3,4-diethylene-1,4-dioxythiophene)) and copper oxides (Cu_2O, CuO) can influence the photoactivity of nanoporous TiO_2 layers. The aforementioned compounds were chosen due to their beneficial properties; PEDOT is highly conductive and stable in its oxidized form and nanoporous TiO_2 can be easily modified by it via electropolymerization. Conversely, copper oxides can decrease electron-hole recombination, which in turn improves photocurrents. Nanoporous TiO_2 was synthesised in a two-step anodization process followed by annealing and electrochemical reduction. Chosen modifications were then introduced to the oxide: Cu_xO was obtained by sputtering of metallic copper and its electrochemical oxidation in NaOH solution, PEDOT by electropolymerisation from an aqueous solution containing the monomer (EDOT).

The morphology of obtained materials – TiO_2@PEDOT and TiO_2@Cu_xO (x = 1, 2) composites – was analysed using scanning electron microscopy (SEM), their chemical composition by energy-dispersive X-ray spectroscopy (EDS) and X-ray diffraction (XRD), and their photoelectrochemical properties by measuring photocurrents under sequential irradiation with light of various wavelengths. Both PEDOT and Cu_xO (x = 1, 2) were successfully used as modifiers of nanoporous TiO_2 layers, which was confirmed by analyses of morphology and composition of obtained materials. During photoelectrochemical testing, both types of composites showed the highest activity at 350 nm wavelength, but their response in the UV range was improved in comparison to non-modified TiO_2. Additionally, an improvement in generated photocurrent was observed under VIS illumination (400-500 nm).

References

[1] K. Lee, A. Mazare, P. Schmuki, Chem. Rev. 114 (2014) 9385−9454

[2] H. Li, J. Zhou, B. Feng, J. Porous Mater. 24 (2017) 97–102