NANOCRYSTALINE TUNGSTEN TRIOXIDE – A NEW PHOTONIC MATERIAL

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Tungsten trioxide is attracting much attention mainly in connection with its use in electrochromic devices and in gas sensors, but also in view of its promising electrocatalytic and photoelectrochemical properties. A variety of techniques are being applied to prepare tungsten oxide films, including chemical vapor deposition, spray pyrolysis, electrochemical deposition and sol-gel methods. A novel version of the latter method, elaborated in this laboratory (1) enabled us to prepare mesoporous thin films consisting of preferentially orientated nanocrystals of tungsten trioxide. Such films exhibit a number of interesting properties: (i)high transparency for the visible wavelengths above 550 nm, (ii)excellent photoelectro-chemical behavior under visible light illumination with the photoresponse extending up to 500 nm, (iii)good adherence to the conducting glass substrate and (iv)high degree of electrochromic optical modulation under lithium or hydrogen ion intercalation in the film. The key feature of the new preparation method is the stabilization of the colloidal solution of tungstic acid precursor by an organic additive such as polyethylene glycol (PEG), glycerol or mannitol. As revealed by the Raman microscope investigations, the addition of PEG to the precursor solution modifies the process of WO_3 film formation occurring during the heat treatment, shifting the definite conversion of the gel into the monoclinic form to higher temperatures. The films obtained by the sequential deposition/annealing (the latter carried out at 500-600°C in oxygen) with thickness ranging from ca 2 to 6 μm exhibited optimum photoelectrochemical properties as photoanodes for oxygen evolution and oxidation of harmful organic effluents. Thinner (less than 1 μm thick) WO_3 films prepared under slightly different conditions were tested in view of an application in electrochromic devices. Also electrocatalytic properties of these mesoporous WO_3 films doped or impregnated with small amounts of noble metals have been evaluated.

References

1. C. Santato, M. Odziemkowski, M. Ulmann and J. Augustynski, J. Am. Chem. Soc., 123,10639-10649 (2001)

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