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Supplementary material

Biochar from spent malt rootlets and its application to an energy conversion and storage device

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Construction of the photoelectrode

1. *Materials*

Unless otherwise specified, all reagents were obtained from Sigma-Aldrich and were used as received. Thus Fluorine-doped Tin Oxide electrodes (8 ohm/square) were purchased from Pilkington (USA), carbon cloth (CC) from Fuel Cell Earth (Wobum, MA, USA) and carbon black (CB) from Cabot Corporation (Vulcan XC72, Billerica, MA, USA).

2. *Construction of the CdS/TiO_2/FTO photoelectrode*

The CdS/TiO_2/FTO electrode was constructed by the following procedure. An FTO glass was cut in the appropriate dimensions and was carefully cleaned first with soap and then by sonication in acetone, ethanol and water. A compact titania layer was first deposited on the clean electrode by a sol gel procedure. A precursor solution was prepared by mixing 3.5 g of Triton X-100 with 19 mL of ethanol to which 3.4 mL of glacial acetic acid and 1.8 mL of titanium isopropoxide was added under stirring. This solution was used for dipping FTO electrodes, which were patterned by covering with tapes the back side and the front side parts which should remain clear. Then it was calcined up to 550°C. This was repeated once, to ensure a complete coverage of the active electrode area. Next, a mesoporous titania layer was deposited on this compact layer by doctor blading, using a paste, composed of Degusa P25 nanoparticles and prepared by a standard procedure based on Reference [1]. The mesoporous film was calcined at 550 °C. This procedure was repeated once again to ensure that a mesoporous film of around 10 μm thickness was obtained. Film thickness was approximately determined by scanning electron microscopy (SEM). The active area of the titania film was 1 cm^2 (1 cm x 1 cm). A fresh titania film was sensitized by CdS nanoparticles by the SILAR method (Successive Ionic Layer Adsorption and Reaction) [2,3] using 0.1 M cadmium nitrate as Cd^{2+} and 0.1 M sodium sulfide as S^{2-} source. 10 SILAR cycles were sufficient to color titania with the yellow CdS layer. This method does not produce a separate CdS layer but rather CdS nanoparticles are formed within the titania mesoporous structure [2] (see image here below). At the end, the film was first dried in a nitrogen stream and then for a few minutes in an oven at 70 °C.

References

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