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Development of molybdenum trioxide-based photoanodes with charge storage capacity for photoelectrochemical water oxidation under illuminated and non-illuminated conditions

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Photoelectrochemical (PEC) technology is one of the most promising methods that convert solar irradiation into storable chemical energy in the form of Hydrogen (H_2) via water splitting reaction. To date, the PEC technology has been studied extensively in terms of the synthesis of photoelectrodes such as synthesis approaches, structural modifications, and improvement of photoresponses. However, the PEC technology is still limited by one of the most challenging bottlenecks where all PEC cells can only be operated under well-illuminated condition. Generally, light source is the most crucial element in a PEC cell as it initiates the photoreactions and producing photogenerated charge carriers. When the light source used is withdrawn (i.e. non-illuminated condition), all the photoreactions will be terminated instantaneously. Therefore, there is a growing significance in enabling the operation of PEC technology under non-illuminated condition via the rational design of photoelectrodes for efficient solar energy conversion and storage. Recently, Molybdenum Trioxide (MoO_3) has attracted numerous research attentions due to its unique layered crystalline structure that leads to charge storage capacity in PEC technology application. Within the MoO_3 structure, a portion of the charges could be stored in the layered crystalline structure via intercalation ($MoO_3 + xNa^+ + xe^- \rightarrow NaxMoO_3$) during the well-illuminated condition. Whilst the stored charges will be released from the molybdenum bronze ($NaxMoO_3$) and continuously flow to the counter electrode via de-intercalation ($NaxMoO_3 \rightarrow MoO_3 + xe^- + xNa^+$) during non-illuminated condition. Thus, the main aim of this work was to synthesize thin films of MoO_3 via the Aerosol-Assisted Chemical Vapour Deposition (AA-CVD) method for application as photoanode used in PEC water splitting. This was followed by a systematic optimisation of the ultrasonication time on the precursor colloidal suspension, and annealing temperature on the eventual crystalline MoO_3 structure formed. FE-SEM images showed that the MoO_3 thin films that are synthesized from the AA-CVD method exhibited a 3D plate-like crystalline structure. Further electrochemical characterisations measured that the AA-CVD synthesized MoO3 thin films possessed a high charge storage capacity of 1.22 mC/cm^2 and a low charge transfer resistance of 87.6 Ω at the optimum ultrasonication time of 25 min and annealing temperature of 550o.

Biography

Chun Yuan Chot graduated in Chemical Engineering with Honours from UCSI University. He joined Monash University, Malaysia for postgraduate studies under the supervision of Associate Professor Dr. Meng Nan Chong, Professor Dr. Ai Kah Soh and Associate Professor Dr. Khang Wei Tan. His research focuses on the development of molybdenum trioxide-based photoanodes with charge storage capacity for PEC water splitting under illuminated and non-illuminated conditions.

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