

Impact of Silicon Surface Modification on the Catalytic Performance Towards CO₂ Conversion of Cu₂S/Si-Based Photocathodes

Authors : Karima Benfadel, Lamia Talbi, Sabiha Anas Boussaa, Afaf Brik, Assia Boukezzata, Yahia Ouadah, Samira Kaci

Abstract : In order to prevent global warming, which is mainly caused by the increase in carbon dioxide levels in the atmosphere, it is interesting to produce renewable energy in the form of chemical energy by converting carbon dioxide into alternative fuels and other energy-dense products. Photoelectrochemical reduction of carbon dioxide to value-added products and fuels is a promising and current method. The objective of our study is to develop Cu₂S-based photoelectrodes, in which Cu₂S is used as a CO₂ photoelectrocatalyst deposited on nanostructured silicon substrates. Cu₂S thin layers were deposited using the chemical bath deposition (CBD) technique. Silicon nanowires and nanopyramids were obtained by alkaline etching. SEM and UV-visible spectroscopy was used to analyse the morphology and optical characteristics. By using a potentiostat station, we characterized the photoelectrochemical properties. We performed cyclic voltammetry in the presence and without CO₂ purging as well as linear voltammetry (LSV) in the dark and under white light irradiation. We perform chronoamperometry to study the stability of our photocathodes. The quality of the nanowires and nanopyramids was visible in the SEM images, and after Cu₂S deposition, we could see how the deposition was distributed over the textured surfaces. The inclusion of the Cu₂S layer applied on textured substrates significantly reduces the reflectance (R%). The catalytic performance towards CO₂ conversion of Cu₂S/Si-based photocathodes revealed that the texturing of the silicon surface with nanowires and pyramids has a better photoelectrochemical behavior than those without surface modifications.

Keywords : CO₂ conversion, Cu₂S photocathode, silicone nanostructured, electrochemistry

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