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Impact of Silicon Surface Modification on the Catalytic Performance Towards CO_2 Conversion of Cu_2S/Si-Based Photocathodes

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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 Cu_2S-based photoélectrodes, in which Cu_2S is used as a CO_2 photoelectrocatalyst deposited on nanostructured silicon substrates. Cu_2S 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 CO_2 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 Cu_2S deposition, we could see how the deposition was distributed over the textured surfaces. The inclusion of the Cu_2S layer applied on textured substrates significantly reduces the reflectance (R%). The catalytic performance towards CO_2 conversion of Cu_2S/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 : CO_2 conversion, Cu_2S photocathode, silicone nanostructured, electrochemistry
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