Efficient solar photoelectrosynthesis of methanol from carbon dioxide using hybrid CuO–Cu2O semiconductor nanorod arrays

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Abstract

Solar photoelectrosynthesis of methanol was driven on hybrid CuO–Cu2O semiconductor nanorod arrays for the first time at potentials [similar]800 mV below the thermodynamic threshold value and at Faradaic efficiencies up to [similar]95%. The CuO–Cu2O nanorod arrays were prepared on Cu substrates by a two-step approach consisting of the initial thermal growth of CuO nanorods followed by controlled electrodeposition of p-type Cu2O crystallites on their walls. No homogeneous co-catalysts (such as pyridine, imidazole or metal cyclam complexes) were used contrasting with earlier studies on this topic using p-type semiconductor photocathodes. The roles of the core–shell nanorod electrode geometry and the copper oxide composition were established by varying the time of electrodeposition of the Cu2O phase on the CuO nanorod core surface.