

Reverse pulse electrodeposition of copper nanoparticles: CO₂ RR on these surfaces

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Abstract: A well-tamed, energy conversion strategy for the valorization of CO₂ is a necessity for maintaining a check on CO₂ levels (~ 500 ppm) and borrow enough time for the scientific community to perfect zero-emission fuel prospects. Mimicking photo synthetically fixed CO₂ by plants in an electrochemical cell is both scientifically intriguing and sociologically promising- given more than half of world still runs on fossil fuel derived energy and standard of life are determined by the intake of energy. Catalysing CO₂RR with economical, selective heterogeneous metal nano-structures proved a promising way to improve upon the status quo.

We synthesised copper NPs by three electrode electrodeposition, to selectively reduce CO₂RR into CO₂+H₂ (synthesis gas) to use it as starting material in well known Fischer-tropsch reaction. In a representative experiment, copper was deposited from CuSO₄ in presence of an ionic liquid and ascorbic acid and collected as NPs on the surface of a carbon fibre paper (CFP). The thin films obtained were nitrogen dried and used as catalyst to reduce CO₂ into value-added fuels. A set of experimental parameters were varied to study the effect of them on morphology, size and activity of the obtained copper NPs. A pulse method involving anodic and cathodic waves passed through the copper anode was found to have a determining capability - be it shape, topology or size of the crystallites.

In a catholyte composed of 0.2 M KHCO₃, cyclo-voltammograms (CVs) were recorded in N₂ saturated and CO₂ catholyte in a 3-electrode, 2-chambered cell. From preliminary results, it was shown that CuNPs showed activity towards CO₂RR as was evident in enhanced faradaic response in CO₂ saturated catholyte. To confirm the path of fixing and valorization, a thorough gas chromatography (GC) analysis was done on the gases that were collected in a Tedlar bag. CO was found to be major reduction product in gaseous phase over-coming the inherit HER (hydrogen evolution reaction) competition on metal surfaces. A significant amount of CH₄ was also measured. The array of obtained products signal role of morphology, the surface topography of catalytic structures on the mechanism and kinetics of CO₂RR

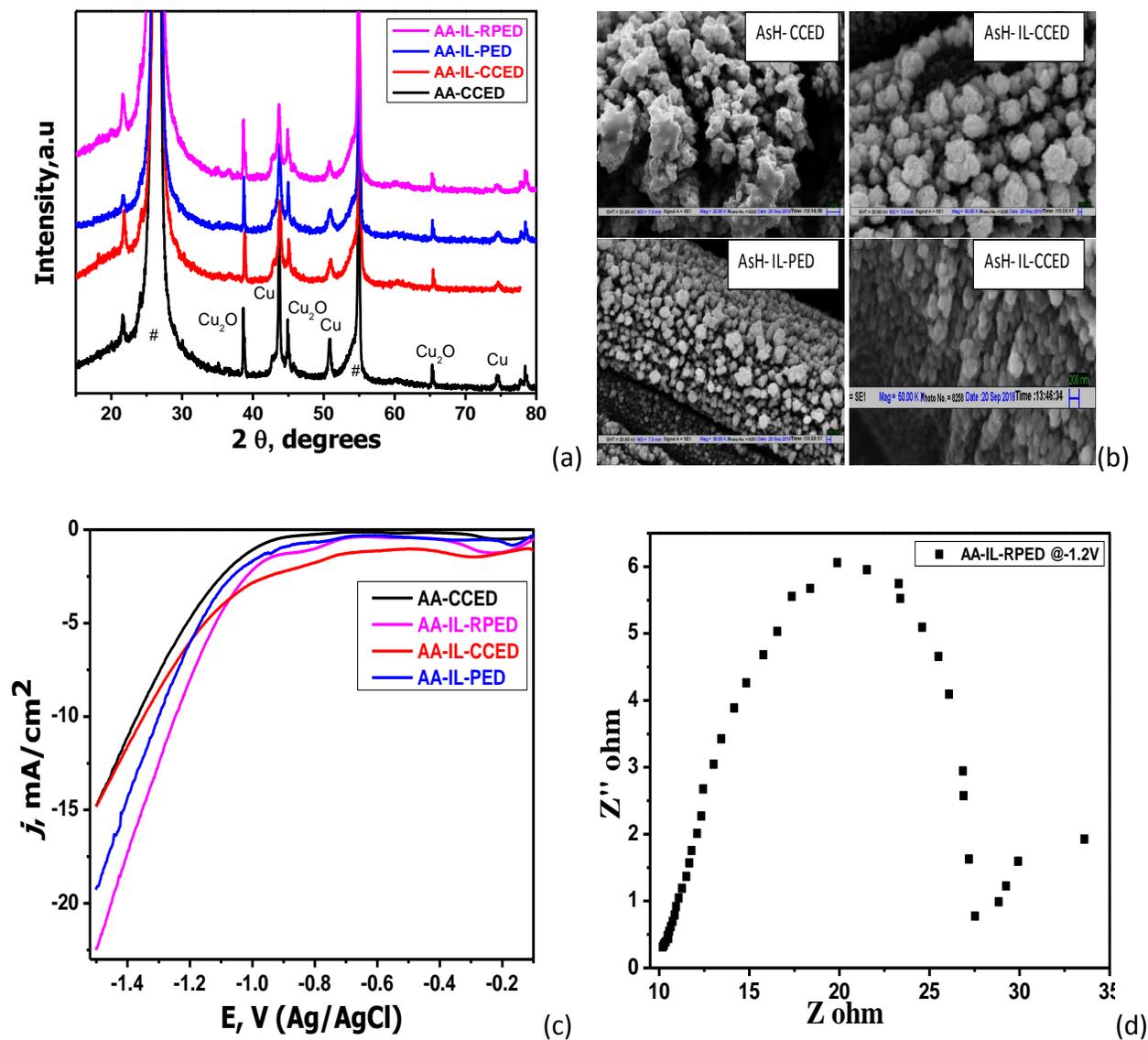


Figure 1: (a) X-ray diffractograms of the samples suggesting Cu/Cu₂O phase present in the sample. (b) FESEM images of different samples suggesting globular type of morphology, (c) LSV polarization curves in 0.2M KHCO₃ CO₂ saturated electrolyte and, (d) Impedance of the RPED sample at -1.2V vs Ag/AgCl of applied voltage.

References:

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5th International Conference on Nanotechnology for Better Living (NBL-2019), Jointly organized by National Institute of Technology (NIT) Srinagar and Indian Institute of Technology (IIT) Kharagpur; April 7 – 11, 2019 at SKUAST, Shalimar Srinagar, Jammu and Kashmir, India; Editor: Dr. M. A. Shah and Prof. P. Banerji, ISBN:978-81-939516-0-6; Published by Applied Science Innovations Pvt. Ltd., Pune, Maharashtra, India.