Dynamics of Copper at Electrochemical CO_2 Reduction (ECR) Conditions

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Copper is the only metal capable of ECR to high-value products besides CO. It is sometimes considered noble, but during electrochemical CO_2 it deviates from this norm and readily degrades [1]. When exposed to electrolyte, the native oxides that was formed upon air exposure dissolve and cause drastic changes to the catalyst morphology [2], which is one of the critical parameters of ECR [3]. Moreover, the dissolved species electrodeposit back on the surface when electrochemical measurement starts, further altering the catalyst morphology due to the competition between ECR and electrodeposition (Figure 1, left) [2]. When applying a cathodic potential relevant to ECR (-1 V vs. reversible hydrogen electrode), all copper reduces to oxidation state zero [4], and dissolution should presumably stop. However, the formation of complexes with ECR intermediates facilitates its dissolution [5]. The dynamic equilibrium between intermediates-mediated dissolution-redeposition leads to the gradual degradation (Figure 1, right) and deactivation of copper catalysts during prolonged operation [2], which is one of the pressing concerns for industrial applications.

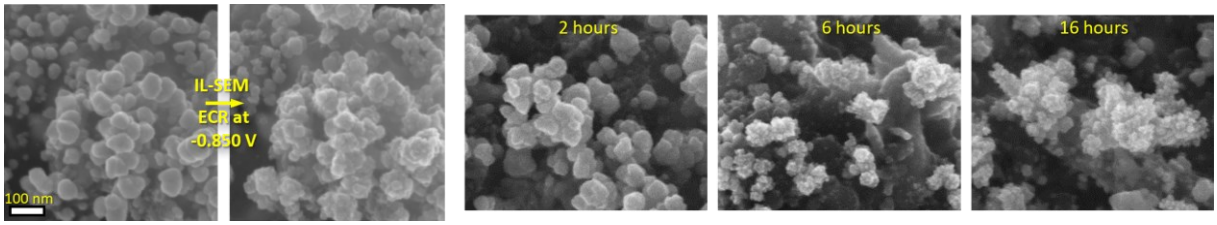

Figure 1: Left) IL-SEM images from before and after ECR experiment depicting fine morphological changes of copper nanoparticles surface. Right) SEM images of copper nanoparticles deformation with time of electrolysis. More data can be found in [2].

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