Optimizing Aqueous-Ionic Liquid Electrodeposition for Anisotropic Growth of Copper and Nickel Nanoparticles

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Copper and nickel nanoparticles are widely used in various catalysis applications. The predominance of particular crystal facets affects their catalytic effectiveness, with the (100), (110), and (111) facets of copper known to have differing product selectivity in the reduction of carbon dioxide,[1] and the (111) facet of nickel is favored for graphite formation from methane cracking.[2] However, current synthesis procedures to produce different morphologies are limited, and subsequently the catalytic activity of only a few facets are well studied. Additionally, synthesis procedures are generally quite energy and time intensive.

Preliminary investigations within our research group into the use of electrodeposition of gold nanoparticles in aqueous-ionic liquid mixtures indicate that ionic liquid ions can enrich specific facets. Since gold shares the same space group and reduction mechanism on the electrode as copper and nickel, it is plausible that electrodeposition in aqueous-ionic liquid mixtures could favor growth along particular facets of copper and nickel. In this work, we investigate how varying the electrodeposition method, potential, metal salt precursor concentration, and the concentration of ionic liquid additives, influences growth and facet selectivity in copper and nickel nanoparticles on glassy carbon electrodes. The ionic liquids cations studied was 1-butyl-3-methylimidazolium $[C_4mim]^+$. The anions studied include: acetate $[OAc]^-$, dicyanamide $[DCA]^-$, tetrafluoroborate $[BF_4]^-$, triflate [OTf[, and hydrogen sulfate $[HSO_4]^-$.

References

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Erika Mitting is an Honours student working under the supervision of Prof Debbie Silvester. She completed a BSc in Chemistry in 2024 at Curtin University in the Materials Chemistry stream. Her research focuses on the electrodeposition of copper and nickel nanoparticles using different electrolytes to study the effect of electrolyte environment on the growth of the materials. She was awarded the 2024 Most Outstanding 3rd Year Student in Chemistry Award and the 2023 Most Outstanding 2nd Year Student in Chemistry Award at Curtin University, Faculty of Science and Engineering Awards.