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Synthesis and characterization of mixed copper and platinum nanoparticles thin films anchored on silica substrate

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Studies involving the synthesis and application of bimetallic nanoparticles (NPs) have gained increasing attention in recent years, not only due to the ability to modulate the properties of these materials based on the synthetic route used, achieving different properties from those observed for metals in their bulk form by controlling the shape, size, and composition of these nanostructures, but also because some of their properties, such as their catalytic properties, are enhanced compared to their monometallic NPs [1]. This study aimed to synthesize and characterize films of monometallic and bimetallic copper (Cu) and platinum (Pt) NPs anchored on silica substrates, employing thermal reduction and varying the copper salts in the precursor solutions. The methodology involved using silica coverslips treated with piranha solution (H_2SO_4/H_2O_2 2:1), which were functionalized with 3-aminopropyltriethoxysilane (APTES) 10% (v/v) simultaneously with the deposition of metal precursor cations in toluene, followed by thermal reduction in a muffle furnace at 300°C for 15 minutes. To understand the relationship between the composition and morphology of the synthesized films and their properties, samples were characterized using UV-Vis spectroscopy, Raman spectroscopy, atomic force microscopy (AFM), scanning electron microscopy coupled with energy-dispersive X-ray spectroscopy (SEM-EDS), and transmission electron microscopy (TEM). TEM images revealed the formation of NPs with crystalline structures, confirmed by dark-field images, and the formation of organized carbon structures in the film obtained with the $Cu(NO_3)_2$ + Pt precursor, similar to graphene sheets. MEV-EDS analysis demonstrated the homogeneous deposition of metals in the $CuSO_4$ and $CuSO_4$ + Pt samples through the proposed thermal route. Furthermore, AFM analysis showed increased thickness and chemical stability after 30 days for the SO_4 + Pt film compared to the Pt-free sample, suggesting higher presence of copper oxides in the Pt-free sample after this period. Due to the observation of significant residual carbon in MEV-EDS, Raman, and TEM analyses, indicating incomplete pyrolysis of APTES during the thermal reduction synthesis stage, additional studies are underway to investigate the impact of temperature and burning time on the characteristics and properties of the resulting films.

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References

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