Seminar

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Institute for Plasma Research

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Title: Cold Plasma Oxidation of Copper Powder

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Date: 30th October 2025 (Thursday)

Time: 10.00 AM

Venue: Seminar Hall, IPR

Abstract

Copper oxide (CuO) has gained significant attention due to its wide range of applications in areas such as catalysis, energy storage, gas sensing, environmental remediation, and healthcare. Traditionally, CuO is synthesized through thermal oxidation, which requires high temperatures and leads to high energy consumption. As a more energy-efficient alternative, plasma oxidation allows the production of CuO at room temperature. This method not only reduces energy usage but also enhances the material's catalytic performance by increasing surface area and exposing active crystal planes, both of which are critical for its functionality.

In this study, we have investigated the cold plasma oxidation of copper powder in an oxygen environment under varying plasma conditions. We examined the influence of reaction time and oxygen gas working pressure on the formation of copper oxides. The working pressure was varied between 0.5 mbar, 1 mbar, and 2 mbar, and for each pressure setting, the reaction time was adjusted to 10, 20, 40, and 80 minutes. X-ray diffraction (XRD) analysis revealed that at lower oxidation levels (lower working pressure or shorter reaction time) the predominant phase was cuprous oxide (Cu2O). At higher oxidation levels, cupric oxide (CuO) became the dominant phase. Since plasma oxidation primarily affects the surface, unreacted copper metal remains in the sample, and its strong XRD peaks make it hard to detect other phases. Raman analysis validated the formation of CuO at higher oxidation levels, supporting the XRD findings, and also indicated the presence of structural defects. X-ray photoelectron spectroscopy (XPS) further confirmed CuO formation and showed a high concentration of oxygen vacancies in the sample. Surface morphology analysis of unoxidized copper showed a dendritic structure. Upon oxidation, initial oxide formation was observed at the edges of these dendrites. With increasing oxidation levels, island-like structures began to form. After 80 minutes of plasma exposure, the development of rod-like structures was noted, although these were poorly formed and lacked uniformity.

In conclusion, this study demonstrates the successful formation of CuO at room temperature using cold plasma oxidation, with structural and morphological changes influenced significantly by reaction time and working pressure.