ARRADIANCE *Sneak Preview*

Impact of Surface Hydroxyl Groups on CuO Film Growth by ALD

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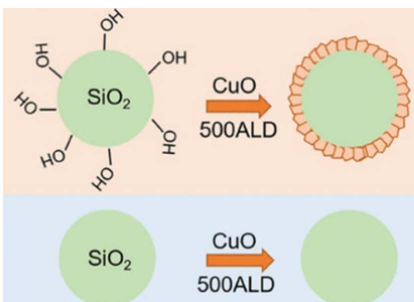
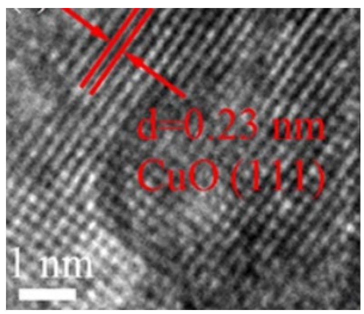
Cupric oxide (CuO), a p-type semiconductor, has recently attracted significant interest for electrocatalysis, photodetectors, gas sensing, and lithium-ion battery applications. It represents a promising candidate for the fabrication of solar cells due to its low thermal emittance, high solar absorbance, and good electrical properties such as a high hole mobility and small band gap. High performance p-type oxide semiconductors promise a new era in the field of transparent electronics and displays by allowing the design of complementary metal oxide semiconductors (CMOS) structures with both n-type and p-type thin film devices, a key to fabrication of compact circuits with low power consumption. A process that ensures precise control over the morphology and crystallinity of continuous CuO films is desired because grain size and film thickness play an important role in the unique electrical properties of CuO, like charge transport.

Previous attempts to deposit copper oxide by ALD resulted in copper(I) oxide, Cu_2O, or mixed valence (I and II). In this new report, scientists from Humboldt University of Berlin in Germany developed a novel ALD process for depositing pure copper (II) oxide (CuO) from copper(II) trifluoroacetylacetonate and ozone, using the Arradiance GemStar™ ALD system. A continuous particulate-like CuO film was grown on surface hydroxyl-rich SiO_2 particles at 200 °C, whereas the surface of the annealed SiO_2 particles (fewer surface hydroxyls) remained uncoated under the same growth conditions. In contrast, a uniform and conformal CuO film (monoclinic *tenorite* phase) was grown on acid-functionalized carbon nanotubes (CNT) using the same growth conditions. CNTs are promising substrates in sensor and energy conversion applications due to their high surface area and electrical properties. The CuO particulate structure was seen with HRTEM on the inside and outside walls of the CNTs at initial stage of growth. After 300 ALD cycles, the particles began to coalesce, forming a continuous crystalline thin film of CuO. Growth remained linear up to 20nm in CuO thickness, at 0.26 Å/cycle.





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This work provides new insights into the role of surface OH- groups on the nucleation and crystallization of metal oxide ALD films and introduces a new strategy to form well-tailored nanostructures.

Arradiance technology enables ALD films in semiconductor industry, solar cell, battery, sensors and electronic applications. For more information on GEMStar™ Technology, ALD systems or Foundry services, please contact Arradiance.