Applications of Atomic Layer Deposition in the Modification of Carbon Nanotubes

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Atomic Layer Deposition (ALD) is a cost-effective nanoadditive-manufacturing technique that allows for conformal coating of substrates with atomic control in a benign temperature and pressure environment. Using paired precursor gases, thin films can be deposited on flat or textured surfaces ranging from glass, polymers, aerogels, and metals. Through atomic layer control, where single layers of atoms are deposited, fabrication of metal transparent films, nano-laminates, and coatings of nano-channels and pores is achievable. Reaction mechanisms in ALD are normally self-limiting, allowing for atomically accurate control of nanometer (nm) thicknesses. Therefore, high uniformity and precise thickness control make ALD an attractive process for the creation of novel nano-scale devices. Decreases in resistivity and density of electrical wire are needed to improve the function of electronics, electric motors and cables. Such improvements may be accomplished by adding ballistically conducting, metallic carbon nanotubes (CNT) to Cu. ALD was used to coat multiple substrates including CNT with Cu in an effort to make CNT-Cu composites which is more conductive and less dense than Cu. In addition, ALD can be used to as a method to deposit the catalyst layer seed layer for CNT growth using Ni. The ALD of copper metallic films can follow multiple reaction pathways depending on the ALD precursors used. For this work the reaction pathway was deposition of copper oxide and then post process annealing in a hydrogen environment. Copper(II) diacetylacetonate (Cu(acac)2) and ozone are used as precursors for copper oxide. As-deposited copper oxide films prepared at 180°C resulted in a growth per cycle of 1.0 Å/cycle with low film resistivity.