

Atomic Layer Deposition of Noble Metals with Low Concentration Ozone

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Noble metal thin films have several potential applications in electronics, protective coating, and catalyst industries. The atomic layer deposition (ALD) of noble metal films are currently achieved using either oxygen or hydrogen as precursors or annealing agents, requiring high temperatures leading to increased risks of explosion and fire. ALD methods not using oxygen or hydrogen as precursors or annealing agents have so far resulted in noble metal oxides instead of pure metal films. An ALD process has been developed for noble metal thin films preparation utilizing low concentration ozone (1.22 g/m3) as a reactant, without the need for any oxygen or hydrogen. This process has been successfully demonstrated for the fabrication of Rhodium (Rh) and Palladium (Pd) thin films. Both metal films exhibited extremely uniform surface with the root mean square (RMS) surface roughness below 0.2 nm. The 20 nm thick metal films had very low resistivity of 12μΩ cm for rhodium and 63 μΩ cm for palladium, showing the deposited metal films had a high purity. The reaction mechanism of palladium ALD from Pd(hfac)2 and low concentration ozone was also studied by density functional theory (DFT). The simulation results show that Pd(hfac)2 dissociative chemisorbed on Si (100) surfaces. Subsequently, ozone reacted with Pd(hfac)* by cleaving its C-C bond to produce gaseous oxygen and adsorbed CF3-OC and CF3-CO-CHO with a relatively low activation barrier. Hence, the reaction was kinetically favourable. The adsorbed complex carbide was then depleted by the excess ozone. The calculated results reveal that pure palladium can be prepared by Pd(hfac)2 and ozone in low concentration without oxygen or hydrogen. All the results indicate that this low concentration ozone based ALD process could yield high quality noble metal films in low temperature and safer way.

Biography

Associate Professor Alfred Tok has been a faculty member in the School of Materials Science and Engineering (MSE) since 2003. He studied Mechanical Engineering at the Queensland University of Technology, Australia, and graduated with First Class Honours in 1995. He was also conferred the Dean's Award for Excellence for being the top graduate. After graduation, he worked as a mechanical engineer at ST Aerospace Engineering. In 1997, he was awarded 2 scholarships at Nanyang Technological University to pursue his PhD in Mechanical Engineering. He obtained his MBA (Dean's List) in 2009 from the Nanyang Business School. His research areas focus on the processing and applications of inorganic materials in the areas of smart materials, biosensors and renewable / sustainable energy. He also consults extensively for companies from various industries.

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