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Synthesis of gold nanoparticles by DC and High-Power Impulse Magnetron Sputtering using a liquid substrate

Q. Advanced functional films grown by pulsed deposition methods – II

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Abstract

Magnetron sputter deposition of metal atoms over vacuum compatible liquids allows producing colloidal solutions of small metal nanoparticles (NPs) without any additional reducing or stabilizing reagents. In this study, gold (Au) atoms are sputtered onto vegetable castor oil to investigate how the experimental parameters affect the growth of Au-NPs. The effect of the deposition time, applied sputter power, working gas pressure, but also the type of sputter plasma (direct current magnetron sputtering (DC-MS) vs. high-power impulse magnetron sputtering (HiPIMS)) on the properties of Au-NPs has been studied by UV-vis spectroscopy and transmission electron microscopy (TEM), and further supported by quantum-chemistry calculations. The mechanism of the Au-NP formation includes the production of primary NPs and their subsequent aggregative growth limited by diffusion in the oil. Au-NPs have a narrow size distribution and a medium diameter of 2.4 – 3.2 nm when produced in DC-MS mode, whatever the chosen parameters. However, the NP size increases up to 5.2 ± 0.8 nm when produced by the HiPIMS discharge which therefore mimics an energy and time-consuming post synthesis annealing process.These nanoparticle solutions are stable over time.

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