Real-time growth monitoring of ultrathin Ag layers: impact of additives on morphological evolution

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Ultrathin silver films with thickness below a few nanometres are interesting candidates for use as Transparent Conductive Electrodes (TCE) in flexible optoelectronic devices **[1]** because of several benefits such as low-cost production, excellent and high electrical conductivity. However, Ag layers deposited by 'conventional' physical vapor deposition on weakly interacting (oxide) substrates have natural tendency to form three-dimension (3D) nanoscale islands, which yield the layers with rough surface morphology, high resistivity and broad absorption bands in the visible range due to the excitation of localized surface plasmons. Deployment of gaseous additives or use of seed layers have been shown to be effective paths for promoting wetting of Ag on the substrate surface, resulting in the formation of a continuous layer at a lower nominal Ag thickness, without compromising the Ag-layer optoelectronic properties **[2]**. However, the impact of additives on the initial film growth stages (in terms of both structural and optoelectronic properties) remains elusive. This gap in understanding can be addressed by in situ and real-time diagnostics.

We will discuss the overall experimental strategy and the initial findings demonstrating the way by which N_2 additives affect the growth morphology of the film using combination of in situ and real-time diagnostics during deposition, such as wafer curvature measurements. Ag thin films having thickness 30 nm can be fabricated by Direct current magnetron sputtering with a Pure Argon (Ar) and Ar + N_2 environment. Adding N_2 gas to film growth completely changes the stress evolution as compared to pure Ar atmosphere and film continuity at lower thickness value as compared to pure Ar environment.

Reference:

1. Yun, J. "Ultrathin metal films for transparent electrodes of flexible optoelectronic devices", Adv. Func. Mater., Vol. 27, 1606641, 2017.
2. A. Jamnig et al., 3D-to-2D morphology manipulation of sputter-deposited nanoscale silver films on weakly interacting substrates via selective nitrogen deployment for multifunctional metal contacts, ACS Appl. Nano Mater. 3 (2020) 4728–4738.

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