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Morphology of Sputtered Gold Thin Films on Si and PET

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Gold thin films enable a wide range of applications such as low resistance contact materials, substrates in biological and organic molecular studies, templates for self-assembled layers as well as reflective and decorative surfaces. Therefore, examination of the film growth of sputtered gold is of high importance.
The grain growth and morphology of 10 to 200 nm thin films of gold were investigated on PET foils and Si wafers. The films were prepared by sputtering at different pressure and power input at ambient temperature. SEM, XRD, and AFM showed on both substrates the presence of spherical grains with a crystallographic preference of (111). For the evolution of the grain growth, the number of grains per unit area was extracted from topographical AFM data. In the early stage of film growth, within 10 and 100 nm, a strong decrease of the number of grains per unit area was observed. The change in grain density is caused by minimizing the total surface energy yielding larger grain sizes and consumption of grains with other orientations. It was found that low deposition rates favor grain formation and the steady-state grain density of around 500 grains per μm^2 was reached already for 60 nm Au films. Ag coatings, on the other hand, revealed lower grain densities due to a higher surface diffusion coefficient. This mode of surface-energy-driven grain growth was finally observed to be dependent on the surface diffusion coefficient, energy flux and deposition rate.
Along with the formation of the grain structure towards a closed film the physical properties were established. Therefore, the optical properties by optical transmission spectroscopy were performed depending on film thickness. Anomalies in optical transmission spectra indicate the conversion from discontinuous to continuous film growth. Optical properties and the optimum adhesion are finally established within the coalescence of the grains.

Keywords
sputtering
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thin film characterization