S-P09

In situ x-ray scattering study of structural evolution of Au thin films during thermal annealing

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Structural evolution of Au thin films during thermal annealing was investigated by in situ synchrotron x-ray scattering and atomic force microscopy. Au thin films with a thickness of ~16 nm were deposited on sapphire(0006) substrates by electron-beam evaporation, and then annealed in air at a temperature of 400 ℃. Upon annealing, Au thin films transformed into Au nano-crystals. We observed a two-step transition process by monitoring the high Q Bragg reflection and low Q reflectivity. In the initial stage, with preserving the coherency of atomic position order along the surface normal direction polygonal-shape holes, mostly triangle and hexagonal shapes, were nucleated in the films, while at an annealing time of 70 minutes the atomic position order was abruptly destroyed by the significant growth of holes that are then contacted each other to form Au nano-crystals. The size of holes is correlated in the in-plane direction resulted in the well-defined satellite peaks in the transverse scans at low Q. Au crystals having a well-defined flat-top surface with the <111> surface normal direction and the facets in the in-plane direction became larger and thicker during the cluster migration process as the annealing proceeded further.