Thermally driven disintegration of the thin metallic films

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Continuous solid metallic thin films can be meta- or unstable after deposited. It results to disintegration (so called dewetting, rupture, self-organization, agglomeration) of the continuous layer into isolated nanoislands [1]. That process can be observed at temperature well below melting point of nanolayer, even at room temperature. The transformation mechanism is driven by thermally accelerated diffusion that leads to the minimalization of surface free energy in the system [2]. Thin films, especially those with nanometer-scale thicknesses, have a relatively high surface energy and a large interfacial area with the substrate. It could create a driving force for the dewetting and form isolated islands. This process is governed by the balance between the energy required to create new surfaces (surface tension) and the energy gained by reducing the total interfacial area (interfacial tension) [3].

The disintegration of a metallic thin films could be used for the preparation of the plasmonic structures [4]. The thermal annealing of nanometric films leads to the isolated island formation. Properties of manufactured nanostructures depend not only on its size, but most of all its nanostructure and chemical composition [5]. Therefore a wide knowledge about kinetics and nanostructures formation parameters play key role from practical applications point of view.

We report the results of our study of the disintegration of the gold thin film and formation nanoislands. To study the effect of silicon diffusion on dewetting and formation of gold nanostructures, thin metallic films were deposited by MBE technique on both, pure silicon and silicon oxide substrates. Transformation of the thin film was observed by LEEM and SEM microscopes, as well as manufactured nanostructures were observed by AFM method. Structural investigations were performed by LEED and XPS methods.

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[1] Giermann, L., Thompson C.V., Appl. Phys. Lett., **86**, 121903 (2005)
[2] 7.Cheynis, F., Leroy, F., Müller, P., C. R. Phys., **14**, 578 (2013)
[3] Thompson, C.V., Annu. Rev. Mater. Res., **42**, 399-434 (2012)
[4] Łapiński M., Kozioł R, Cymann A., et al., Plasmonics, **15**, 101-107 (2020)
[5] Kozioł R., Łapiński M., Syty P., et al., Surf. Sci., **567**. 150802, (2021)