Nanocomposites and nanomaterials

Evolution of lattice papameters porous structure obtained using laser ablation of gold

S.B. Kryvyi, O.Y. Gudimenko, I.M. Krishchenko, V.P. Kladko

V.E. Lashkaryov Institute of Semiconductor Physics, NAS of Ukraine,
41, Pr. Nauki, Kyiv, Ukraine, E-mail: serkriviy@gmail.com

Recently, interest in noble metallic nanoparticles has been growing steadily due to their plasmonic properties. It was shown, that the pulsed laser deposition allows high precision control structural and therefore plasmonic properties. However, careful structural study is needed for understanding the physical processes deposition mechanism.

Porous gold films (por-Au) have been produced by the pulsed laser deposition method with a YAG:Nd^{3+} laser (a wavelength of 1.06 μm, pulse duration of 10 ns, repetition frequency of 25 Hz) in an argon atmosphere with a variable pressure P_{Ar}, pulse number N and laser fluence. The structural investigation where provided by X-ray diffractometry and X-ray reflectometry. As is known, the structural properties of nanoparticles are determined by the surface tension, and as a consequence - the change in lattice parameters in comparison with a bulk material. We have studied the influence of structure formation conditions on the lattice parameters of gold nanoparticles (Au NP).

We observed nonlinear dependence of the lattice parameter on argon pressure Fig. 1. Obviously, at low pressures, NP coagulate. However, the increasing pressure of 20 Pa decreases coagulation as the substrate reaches smaller particles and their energy decreases through interaction with the gas. This creates conditions for the formation of relatively isolated particles whose surface tension reduces the lattice parameter. When the pressure increase to 70 Pa, only large, high-energy particles reach the substrate. Relatively large size of these particles is reduced compressive deformation.

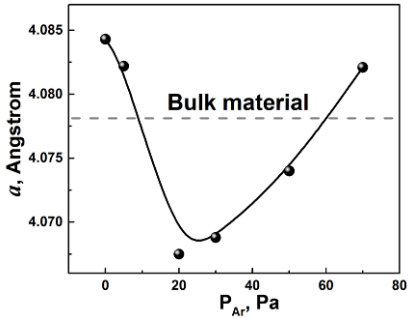

Fig. 1 dependence of the lattice parameter Au NP on argon pressure. Symbol indicate experimental data and dash line - lattice parameter of bulk material from literature