# Investigation of the Structure of Nanoporous Gold Plasmon Films by X-Ray Diffraction and Reflectometry

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Plasmon nanoporous gold films (npor-Au) are the nanocomposite, nanoporous films containing gold nanoparticles (Au NPs) with the optical properties of localized surface plasmon (LP) resonance. Films prepared by pulsed laser deposition of forward and backward flows particles of erosion torch in argon atmosphere by beam of IAG:$Nd^{3+}$ laser on gold target.

Diffraction measurements were carried on the installation ARL X'tra (Thermo Scientific) using the grazing beam. X-ray reflectometry (XRR) measurements were performed on PANalytical X'Pert PRO MRD using $Cu_{k\alpha 1}$ ($\lambda$=1.5406 Å) characteristic radiation. Simulation and fitting of the reflectometry curves was carried on the X'Pert Reflectivity software.

It was established that the structure of Au NPs belongs to the polycrystalline phase with face-centered cubic lattice (fcc). It was defined that the average size of Au NPs increase from a few nanometers to 10-15 nm with increasing pressure of argon from $P_{Ar}$ = 10 to 100 Pa. Small sizes Au NPs experience compression due to surface tension, the lattice parameter is equal to $a$≈4,0646 Å. The values of lattice parameter Au NPs achieves close to the values in the bulk gold $a$≈4,0852 Å if pressure of argon rise. The smallest value $a$ characterizes lattice of Au NPs in the films obtained by the backward flows clusters on films areas that located far away from the axis torch. The obtained values of the lattice parameters were used to clarify the porosity of the gold films obtained by XRR. Porosity films increase from a few percent to ≈60% with increasing argon pressure. It also increases with decreasing film thickness. In the reverse transfer of torch's clusters it was obtained the films with gradient thickness, size of Au NPs and nanopore. We have studied the influence of film formation conditions (number of pulses in the pulse energy density, etc.) on the structural parameters of the films.

The obtained results are used to control the plasmonic properties of the films. We received films npor-Au with maxima of extinction curves with LP resonance in a wide wavelength range 550-740 nm. Most long-wave region are caused multipole generation, visible spectrum — dipole due to the internal size effect.