

XAFS study of AgAu nanoparticles formation in glass by UV laser irradiation

L.A. Bugaev(a), M. Heinz(b), V.V. Srabionyan(a), , L.A. Avakyan(a), A.L. Bugaev(c), A.V. Skidanenko(a), S.Yu. Kaptelinin(a), J. Ihlemann(d), J. Meinertz(d), Ch. Patzig(e), M. Dubiel(b)

bugaev@sfedu.ru

(a) Southern Federal University, Department of Physics, Zorge Str. 5, RU-344090 Rostov-on-Don, Russia, (b) Martin Luther University Halle-Wittenberg, Institute of Physics, Von-Danckelmann-Platz 3, D-06120 Halle (Saale), Germany, (c) Southern Federal University, The Smart Materials Research Center, Sladkova 178/24, RU-344090 Rostov-on-Don, Russia, (d) Laser-Laboratorium Göttingen e.V., Hans-Adolf-Krebs-Weg 1, D-37077 Göttingen, Germany, (e) Fraunhofer Institute for Microstructure of Materials and Systems IMWS, Walter-Hülse-Str. 1, D-06120 Halle (Saale), Germany

Au and Ag nanoparticles (NPs) find wide applications due to their linear and nonlinear optical properties such as the surface plasmon resonance (SPR), which enables to localize electromagnetic field on nano-scale distances. Shape and wavelength position of SPR (λ_{SPR}) depend on the size and shape of NPs, degree of their agglomeration and hence can be tuned by choosing the synthesis conditions. The properties and the efficiency of such materials can be improved and enhanced by using bimetallic AuAg NPs instead of the monometallic ones.

Calculations of optical extinction spectra (OES) for different hypothetical core-shell models of AuAg NPs by generalized Mie theory [1] revealed that the shift of λ_{SPR} can be of ~ 3 -4 times larger than in corresponding monometallic NPs or in thin films. To obtain submicron line patterns of spatially arranged arrays of plasmonic NPs in the near-surface region of glass, it is preferable to use the approach based on the irradiation of the preliminary prepared glass by UV laser using laser masks or gratings. By this approach, arrays of Ag and Au NPs in silicate glass were obtained using ArF-excimer laser irradiation (193 nm) of the glass: i) containing Ag^+ ions, preliminary incorporated via $Ag^+ \leftrightarrow Na^+$ ion exchange – for Ag NPs preparing [2]) and ii) of the glass, sputter coated with a thin gold layer – for Au NPs [3]. In this study these techniques are combined for the creation of arrays of bimetallic AuAg NPs in the near-surface glass region via laser irradiation of silver doped silicate glass sputter coated with a thin gold layer.

The used approach seems promising since the Au NPs formed in the near-surface glass region after the first few laser pulses [3] can be considered as the suitable nuclei for precipitation of the reduced silver atoms on them, thus obtaining AuAg NPs. The TEM gave the evidence of NPs formation and the OES of samples AuAg/glass demonstrated the appearance and transformation of SPR with the increasing number of laser pulses. The structural characterization of NPs was performed using the technique for the processing of Au L_3 - and Ag K-edge XAFS [4]. It was revealed that the NPs architecture core(Au)–shell(Ag) is formed by the low number of laser pulses (< 20) and is transformed then to the structure of disordered alloy when the number of pulses increases. The OES calculated for NPs structures determined by XAFS analysis, show their consistency with the experimental data and gave the dependences of SPR parameters upon the percentage of components (Au:Ag) in the core-shell and in disordered alloy architectures.

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