Experiment 08-01-960, BM08

Title: Au-Ag cluster nucleation in Er implanted silica

Participants: Chiara Maurizio, Valentina Mattarello, Raju Edla

Experimental conditions: XAS at Au L_3 and Ag K-edges, fluorescence mode, grazing incidence geometry

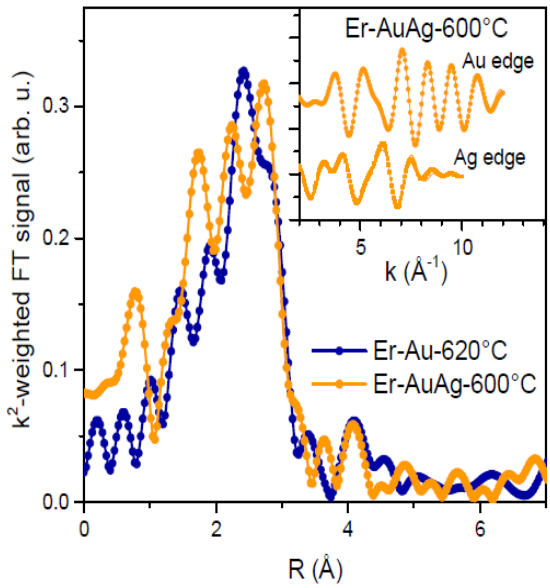
Samples measured (EXAFS at the metal edge(s)):

Au+Ag implanted silica: as implanted and 600 C annealed (N_2, 1h)

Er+Au+Ag implanted silica: as implanted and 600 C annealed (N_2, 1h)

Ag implanted silica: 600 C annealed (N_2, 1h)

The EXAFS (Extended X-ray Absorption Fine Structure) experiment was performed at both Au L3 and Ag K edges, to track the formation of few-atoms metal clusters, their average composition, as well as any possible metal-oxygen correlation. The sagitally focusing monochromator was equipped by a couple of Si (311) crystals. For Au-edge (Ag-edge) measurements the harmonics rejection was achieved by a couple of Pd-coated (Pt-coated) mirrors. Due to sample dilution, the x-ray absorption spectra were measured in fluorescence mode by a 13-element HP Ge detector. To enhance the fluorescence signal over the elastic scattering a grazing incidence geometry was used (incidence angle of 2 deg). Samples were cooled to about 100 K to limit atomic thermal vibrations. EXAFS data analysis was performed on the two edge spectra at the same time, within the single scattering approximation. In the Fourier transform moduli of the EXAFS spectra for the samples Er+Au and Er+Au+Ag are shown (Au-edge), measured after annealing at 600℃. The only significant signal is in the region



k^2-weighted Fourier transform moduli of the Au L_3-edge EXAFS spectra for the samples Er-Au and Er-AuAg, after annealing at 600 °C. Inset: k^2-weighted EXAFS signals (Au and Ag edges) filtered in the range R=1–3 Å for the sample Er-AuAg annealed at 600 °C. Corresponding fits (line) are superimposed to the experimental data (dots).

R=1-3 A, where the contributions of Au-O and Au-metal correlations partially overlap. Similar considerations are found for Ag-edge spectrum. The EXAFS analysis for the sample Er+Au+Ag-600°C evidences a Au-Ag coordination in both Ag and Au edge spectra, proving the formation of Au–Ag alloy structures (in the inset of the Figure fits are superimposed to the filtered experimental data). The interatomic distance (R(*Au–Ag)*=2.75±0.02 A) is considerably contracted with respect to the one of Au and Ag bulk (R=2.88 A), due to the small size of the alloy aggregates. Considering for Au and Au-Ag clusters roughly the same size equation to relate interatomic distance with cluster size (bulk Au, Ag and Au*x*Ag1−*x* have the same lattice parameter) we suggest that the alloy structures are formed of about 10-15 atoms.

The analysis allows to correlate the alloy cluster nucleation with the photoluminescence intensity of the Er ions embedded into the same matrix. A paper is in preparation.