Report of the experiment ME-1185: Ag and Tl ion-exchange waveguides: an EXAFS experiment to investigate and compare the local structure around the two dopants..

The aim of the experiment was to compare the local order around Ag atoms and Tl atoms in Ag-for-Na and Tl-for-Na ion-exchanged borosilicate glass. This investigation we will help to clarify if and how the difference of polarizibility between Tl^+ and Ag^+, exploited for obtaining optical waveguides, acts upon the local order around theses cations in the borosilicate glass matrix. The dependence of the Ag and Tl site on the bath composition (Ag or Tl concentration) and preparation temperature was investigated. The EXAFS experiment was performed at the Ag K-edge and Tl L_3-edge in fluorescence mode by a 13-element HP Ge detector. Since the thickness of the Tl-doped layer was about 10 nm below the sample surface, a grazing incidence geometry was used to enhance the fluorescence signal from Tl; the incidence angle was about 0.18 deg (a_c~0.14 deg). The EXAFS analysis exploited FEFF8-FEFFIT package.

The sample name is composed of the dopant symbol (Ag or Tl) followed by the molar concentration of $AgNO_3$ or $TlNO_3$ in the $NaNO_3$ bath and by the bath temperature (°C). The results of the EXAFS analysis at the Ag K-edge are reported in the table for the first Ag-O coordination shell (coordination number N, Ag-O distance R and Debye Waller factor σ^2). It comes out that:

- Ag is mainly coordinated with O.
- The Ag-O distance is much larger than in the Ag_2O.
- The number of O atoms around Ag is slightly lower than for Ag_2O.
- The Ag-O distance increases by increasing the Ag concentration into the bath, becoming similar to the Na-O one.
- The Ag-O distance decreases for the samples treated at high temperature

The EXAFS analysis at the Tl L_3-edge indicate that the EXAFS signal is extremely small; on the other hand, the Fourier analysis (not reported) indicates that a complex structure is present for all the recorded spectra, due to at least two (maybe three) different coordinations. Work is in progress to investigate this point.

Sample name	N (±0.2)	R (Å) (±0.02)	σ^2 ($\times 10^{-4}$ Å^2) (±20%)
Ag-0001-330	1.5	2.22	91
Ag-001-330	1.5	2.27	116
Ag-02-330	1.6	2.30	132
Ag-02-350	1.6	2.29	118
Ag-02-380	1.4	2.27	119
Ag-04-330	1.9	2.30	138
Ag-04-350	1.6	2.30	140
Ag-04-380	1.3	2.28	85
Ag_2O	2	2.04	-
Na-O in glass[5]	4-5	2.30-2.43	-