MICRO- AND MACRO-MECHANICAL PROPERTIES OF ALUMINOPHOSPHATE GLASSES DEPENDING ON THEIR COMPOZITION AND LOADING CONDITIONS

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In this study the deformation peculiarities of aluminophosphate glasses (Li_2O-Al_2O_3-BaO-La_2O_3-P_2O_5) doped with Dy, Tb and Fe were investigated at concentated load action (indentation) and uniaxial compression. Dynamic nanoindentation techique with Berkovich indenter were used for hardness (*H*) and elastic modulus (*E*) measurements, as well as for the investigation of the kinetics of deformation through the analisys of strain rate during indentation and its influence on the deformation mechanisms.

It is known that there are two main mechanisms responsible for the plastic deformation of glassy matrix: particular modes of shear flow and permanent densification. The contribution of densification influenced by strain rate under indentation was studied by using thermally-induced indentation recovery that takes place mainly at the expense of densification. It was shown that the decrease of load and loading (strain) rate leads to the increase of densification contribution to the total process of deformation under indentation (Fig.1). The influence of loading rate on hardness is not so pronounced although some growth of hardness with rate increase was observed.

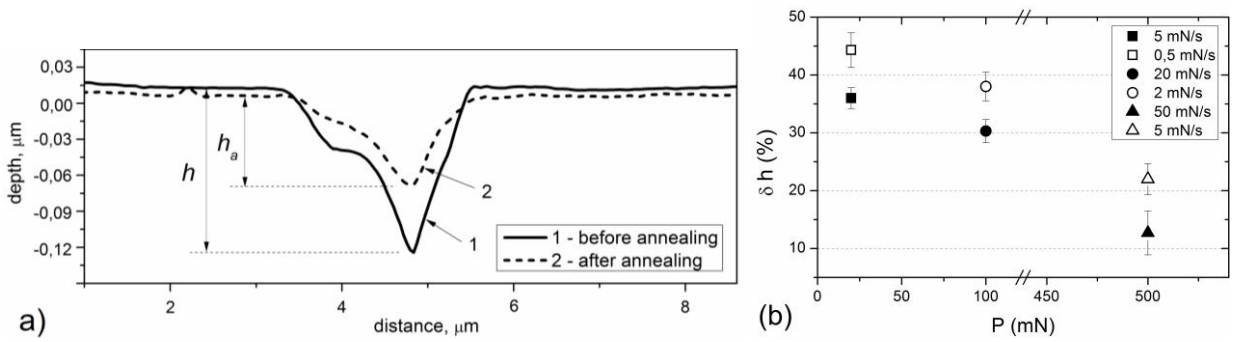

Fig.1. (a) AFM profiles of indentation made at 20 mN load and 0.5 mN/s loading rate showing the thermally-induced indentation recovery $\delta h = (h - h_a)/h$. (b) The dependence of relative recovery of indentation depth on the loading rate (indicated in the legend) and load.

The strain rate appears to be responsible for different behavior during uniaxial compression (macro-scale) as well, that becomes apparent by higher ultimate strength and strain that the material can withstand during longer period of time before disruption when the deformation occur at slower rate. This is consistent with the results obtained under concentated load action (micro-scale).

By using quasistatic Vickers microindentation method the fracture toughness evaluation were performed. The addition and change of doping element does not affect essentially the fracture resistance, the values ranging from 0.79 to 0.83 $MPa \cdot m^{1/2}$. As for hardness, it was observed an increase with the addition of Fe and Dy and a small decrease with the addition of Tb, the values ranging from 5.54 to 6.25 GPa for 100 mN load. These are rather good parameters that testify to good homogeneity and low defect structure of glasses due to the application of non-conventional wet chemical raw materials processing technique for their fabrication.