Thermal, mechanical and structural properties of tellurite glasses

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Abstract

We present a study of glasses in the systems ZnO-TeO2 (including pure TeO2 glass) and R2/3O-ZnO-TeO2 (R=B, Al) where ZnO is replaced by B2O3 or Al2O3. Glasses were prepared by quenching the melts from Pt crucibles, and their glass transition temperature Tg, density, mechanical properties and Raman/infrared spectra were measured to correlate glass properties with structure as a function of composition. TeO2 and ZnO-TeO2 glasses prepared by melting in Pt crucibles were found to exhibit profound differences in terms of properties and structure when compared to similar glasses melted in alumina crucibles, a method used frequently in the literature. The origin of such differences was traced to doping of the tellurite matrix with Al2O3 leached from the alumina crucible. Raman spectroscopy reveals cross-linking of the tellurite network by Te-O-Al bridges, resulting in the increase of Tg (by as much as 75 oC for TeO2 glass), the decrease of density and the strengthening of mechanical properties. Replacement of ZnO by Al2O3 or B2O3 leads to strongly- and weakly-interacting tellurite-aluminate and tellurite-borate structures, respectively. The findings of this study are discussed in relation to the strengths of Te-O, Al-O, B-O and Zn-O bonds. We acknowledge support of this work by the project "Advanced Materials and Devices" (MIS 5002409), implemented under the "Action for the Strategic Development on the Research and Technological Sector", funded by the Operational Programme "Competitiveness, Entrepreneurship and Innovation" (NSRF 2014-2020) and co-financed by Greece and the European Union.

Keywords: tellurite glasses, thermal and mechanical properties, structure by Raman and infrared spectroscopy

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