Structural studies of tellurite glass, anti-glass and crystalline phases

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Abstract

Tellurites are technologically important materials which exist in glass, anti-glass and crystalline phases. Pure TeO2 forms glass under the condition of high melt-quenching rates; while binary and ternary tellurite systems containing alkali, alkaline-earth, rare-earth, transition and heavy metal oxides form glasses rather easily at normal quenching rates and have wide glass-formation range. Tellurite glasses have a dual Te-O coordination (NTe-O) of 3 and 4 with oxygen. NTe-O can be determined by Raman and neutron diffraction studies; and it decreases on incorporating metal oxides such as ZnO, Al2O3, BaO, PbO, WO3, Nb2O5, Eu2O3, Nd2O3 and MoO3 into the tellurite and borotellurite network. Borotellurite glasses that contain two glass formers i.e. B2O3 and TeO2 form transparent glasses over B2O3 concentration of 5 to 25-mol%. 11B Magic Angle Spinning Nuclear Magnetic Resonance (MAS-NMR) and infrared spectroscopy studies confirm that the boron-oxygen co-ordination (NB-O) decreases with increase in B2O3 mol% in borotellurite glasses. Pure borotellurite glasses are hygroscopic and absorb atmospheric water vapors to form crystalline precipitates a-TeO2 in an amorphous matrix. On adding Al2O3 into borotellurites to form alumino-borotellurite glasses, the chemical durability enhances but the glass formation range deteriorates due to decrease in NB-O. Bi2O3 and Nb2O5 when added into TeO2 form highly intriguing anti-glass inclusions of the size of several microns within a glass matrix. An anti-glass is a solid, which has long range order of cations (Te4+, Sr2+, Bi3+, Nb5+ etc.) but these are statistically distributed at their sites while the anion sites are partially vacant. Consequently the X-ray diffraction patterns of bismuth tellurite and bismuth niobium tellurite anti-glass samples show sharp peaks but the Raman spectra show broad phonon bands. In this talk an overview of structure-property correlation studies of several tellurite systems by X-ray diffraction, neutron diffraction, MAS-NMR and Raman spectroscopy is presented.

Keywords: Tellurite glasses, inclusions, structure, diffraction, Raman spectroscopy, microscopy

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