Structural investigation of glasses in the BaO-B2O3-SiO2 system with coupled Raman/Brillouin spectroscopy

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Abstract

Porous substrates with low permittivity and high electrical resistance could provide opportunity to develop new generation of high frequency devices. By taking advantage of phase separations occurring in borosilicate systems, we might be able to create such new devices after selective etching of the boron-enriched phase.
Since structural data of glasses in the ternary system BaO-B2O3-SiO2 (BaBSi) are limited, using a coupled Raman-Brillouin spectrometer (ARABICA) we could directly observe and correlate changes on the elastic properties and structure.

Two series of glasses, in the ternary system were synthetized. The first one has an almost constant SiO2/B2O3 molar ratio (_˜1) and spans perpendicularly to the immiscibility gap. The second glass series has a constant BaO amount (32 mol%), and progress parallel to the decomposition area. The effects of BaO content and SiO2/B2O3 molar ratio on both B-coordination and on the global network connectivity were investigated following the vibration modes for Si and B in the Raman spectra.

In the high frequency envelope (1200-1600 cm-1), related to boron stretching modes, we can observe the change from BO3-BO4 to BO3-BO3 coordination with increasing boron content. In details, the frequency position of the two main bands slightly increases whereas, the relative intensity of the bands related to 3-fold coordinated boron strongly increases with respect to the 4-fold coordinated one. The Brillouin spectroscopy results show that mechanical properties are related to the extent of the network variations. In decomposed samples we noticed the appearance of two peaks in the Brillouin spectra, which might be related to silica and boron phases.
From the results here obtained we will propose a model estimating the changes of B coordination in the BaBSi ternary system and relating them to property changes (such as electrical properties).

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