Infrared and terahertz dielectric spectra of novel Bi2O3-Nb2O5 microwave ceramics

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Abstract

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(1-x)Bi2O3-xNb2O5 system has been recently found as a perspective class of materials for LTCC microwave ceramics with a composition-dependent relative permittivity between 50 for x = 0.1 and 120 for x = 0.28 [1]. The most attractive properties were found for x = 0.25 and x=0.26 compositions with the permittivity of 90, for which an ordered tetragonal fluorite-based structure can be stabilized at 900°C. We have studied 15 samples out of this system for x = 0.1 to 0.26 and different sintering conditions using quantitative infrared (IR) reflectivity and time-domain terahertz (THz) transmission spectroscopies, covering the range of 0.1-100 THz. The joint spectra were fitted using a factorized form of the complex permittivity consisting of 6-9 generalized oscillators which describe the response of IR polar phonon modes. They show an unusually high damping. No appreciable dielectric dispersion was found between the THz and microwave permittivity. The THz losses show the theoretically expected proportionality to frequency *mu* f, but extrapolation to microwave range (5 GHz) yield mostly somewhat lower losses than those directly measured. Only in the case of the sample with x = 0.26, sintered at 900 °C for 2 h, the extrapolation agreed with the highest directly measured microwave Qxf factor of 1000 GHz at = 86 with tf = 120 ppm/K. This indicates the optimal processing conditions for this sample.

[1] M. Valant, D. Suvorov, J. Am. Ceram. Soc. 86, 939 (2003).