Elaboration, structure, nonlinear optical and lasing properties of tellurite based glasses and glass-ceramics.

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Abstract

Tellurium dioxide-based glasses are currently considered as very promising materials for high-index and nonlinear optical devices because of their high nonlinearities ($\chi(3)$ hypersusceptibility far (50 times) exceeding that of glassy SiO2), their high Raman gain coefficients (60 times higher than that measured on a reference Corning 7980-2F silicate glass) and their good visible and infrared light transmittance (up to 7 micronmeter). Therefore, some substantial literature has been devoted to the studies of such tellurite glasses during the last decade. Many binary and ternary phase diagrams were investigated and the existence of large glass-forming domains was evidenced for most of them. This conference will present a review of the activities developed in the IRCER laboratory of Limoges since about 20 years on these materials in concentrating mainly on the following topics: (i) synthesis of glasses and transparent glass-ceramics and ceramics, (ii) structural characterization using the total scattering technique and atomic scale modelling methods (molecular dynamics or Reverse Monte-Carlo simulations), (iii) modelling of the nonlinear optical properties, (iv) 3rd-order and second harmonic generation, (v) lasing properties. Our challenge was to elaborate the optimal chemical composition of TeO2-based glasses that affords a compromise between structural, mechanical and thermal properties on the one hand, and desirable nonlinear optical properties on the other hand. Our results have confirmed the high potentiality of TeO2-based materials in the field of nonlinear optics. Especially, the high third-order susceptibilities of glasses have been demonstrated. Second harmonic generation has been evidenced in glasses using either thermal poling or optical poling. All these properties have been clearly related to specific structural characteristics of tellurite phases, i.e; the presence of different structural units and the nature of their linking (as the chain-like polymerization), the presence of the lone pair on tellurium atom. Using *ab initio* calculations we have

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demonstrated that the mechanism of the nonlinear electronic polarization in tellurite glasses was mainly associated with the electron mobility within the chains formed by polymerized Te-O-Te bridges. Laser emission has been obtained in Nd3+-doped tellurite glasses.

Keywords: Tellurite glasses, glass structure, X, ray total scaterring, atomic scale modeling, nonlinear optical properties