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Heavy-metal oxide glass containing Te^0 nanoparticles and CdS *quantum-dots* for photonic applications

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Highlights

Controlling the synthesis in-situ of Te^0 nanoparticles and CdS quantum dots in tellurite and fluorophosphate glass induced by sulfide precursor and fs-laser irradiation for fabrication of planar waveguide.

Abstract

The aim of this work is to present the systematic study and comprehension of optical heavy-metal oxide glasses, e.g. tellurite (TeO_2-based) and fluorophosphate glasses, containing chalcogenide-based nanoparticles, such as Te^0 and luminescent CdS quantum dots, grown in-situ, for different photonics applications. The features of optical oxide glasses make them promise for photonic and optoelectronic applications due to broad transparency from ultra-violet to visible range, large thermal stability against crystallization and high linear refractive indexes. Glass samples were obtained by melting-quetching method and characterized with several techniques, such as differential scanning calorimetry (DSC), X-ray diffractometry (XRD), Raman and electronic spectroscopies, transmission electron microscopy and selected area electron diffraction (TEM/SAED), X-ray photoelectron spectroscopy (XPS) and photoluminescence. At first, the synthesis of Te^0 nanoparticles from controlled Te^{4+} reduction aimed to study and explain the in-situ redox process that occurred in the tellurite matrix (TeO_2-based glass). Moreover, in order to have a localized control of the redox process, the technique of fs-laser micromachining was used to explore the possibility of planar waveguide fabrication and to develop new material for data storage. In other words, the understanding and controlling of the tellurium redox phenomenon into a vitreous matrix by fs-laser becomes very important because it induces localized changes of the material refractive index (planar waveguides) and photo-darkening process (data storage or photosensitive materials). Lastly, a new fluorophosphate glass was studied with emphasis on their structural, optical and thermal stability against crystallization for in-situ synthesis of highly luminescent CdS quantum dots obtained through controlled heat-treatment (nucleation and growth) on the glass transition temperature. The CdS QDs size and distribution have a strong influence on the optical and luminescent properties, and the control of those parameters makes this doped glass promising for photonic applications in the visible range.

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