Holmium-doped TeO_2–ZnO–La_2O_3 tellurite glasses for photonics applications and fibre optics

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Optical materials doped with rare earth (RE) ions still represent great potential for photonics applications, especially in the design of light-emitting materials and optical amplifiers. Despite the continuous increase in transfer capacities in the current telecommunications bands, it is clear that new bands are to be involved. The first alternative to the most widely used C-band (1.53-1.565 μm) was initially the extension to the L-band (1.565-1.62 μm). However, even this extension does not represent a long-term sustainable solution. One of the suggested options is to use an additional optical band located at the 2 μm, which could use materials doped with Ho^{3+} or Tm^{3+} ions for the design of optical amplifiers to compensate optical losses. While erbium-doped fibre amplifiers can thus operate effectively in the C and L transmission bands, no similarly capable alternative is currently available for the intended optical band at 2 μm. Although the tested holmium-doped fibre amplifiers exhibit high conversion efficiency and low optical losses compared to, for example, Tm-doped materials, a suitable pumping scheme using commercially available pumping lasers is still not available.

This work presents a thorough investigation of the effect of simultaneous doping of host TeO_2-ZnO-La_2O_3: 0.5 mol.% Ho_2O_3 glasses by various RE^{3+} ions, such as Yb^{3+}, Er^{3+}, Nd^{3+}, Tm^{3+} Sm^{3+}, Dy^{3+} and their combinations on photoluminescent properties under 800 nm and 980 nm excitation. The experimental results thus allow a comprehensive study of the excitation mechanism for Ho^{3+} ions in tellurite glasses with respect to observed photoluminescence and photon upconversion from the visible to the mid-infrared region of the spectrum. Targeted 2.0 μm photoluminescence emission (λ_{exc} = 980 nm) was observed for all Ho^{3+}/RE and Ho^{3+}/RE_1/RE_2 doped glasses, except for Ho^{3+}/Sm^{3+} glasses. The highest intensity under 980 nm excitation was observed for samples containing Yb^{3+} ions.

References

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