Designing and Creating Low-Loss Infrared-Emitting Nanostructured Active Photonic Composites

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Abstract

Infrared-emitting erbium (Er) doped systems are often used to fabricate the active optical components in photonic devices since the radiative transition of Er^{3+} ions falls within the telecommunication window. [1] In a typical waveguide amplifier, light is guided in a high refractive index core that is surrounded by a lower index cladding material (Fig. 1a). Er-doped inorganic nanocrystals dispersed within polymer matrices to form polymer-based optical waveguide amplifiers offer an attractive low cost versatile solution. To obtain highly emissive nanocomposites, it is critical to maximize nanoparticle loading in the polymer matrix while minimizing scattering and absorption losses. Absorption losses are mostly dictated by the optical properties of the polymer matrix, whilst scattering losses are typically affected by the primary particle sizes, agglomerate size and refractive index mismatch between the inorganic particle and polymer. In this presentation, we will discuss the solution-based synthesis of Er-doped nanoparticles of ~20-30 nm with enhanced IR emission efficiency by controlling the nanostructure and dopant chemistry of as-synthesized particles (Fig 1(b) and (c)).[2, 3] We will also present how we have tailored the surface chemistries of our infrared-emitting inorganic nanoparticles with a unique amphiphilic POSS-based surfactant which was designed to improve the dispersion behavior of our particles in various polymers. Using our approach, we have demonstrated the successful fabrication of an infrared-emitting nanostructured composite that has exhibits mostly single particle dispersion at high solid loading of up to 10 vol%. The high IR-emitting efficiency, small particle sizes and excellent dispersion control of our particles within various polymer matrices demonstrate the promising potential of our polymeric composites for a myriad of applications, including fiber amplifiers and waveguides.

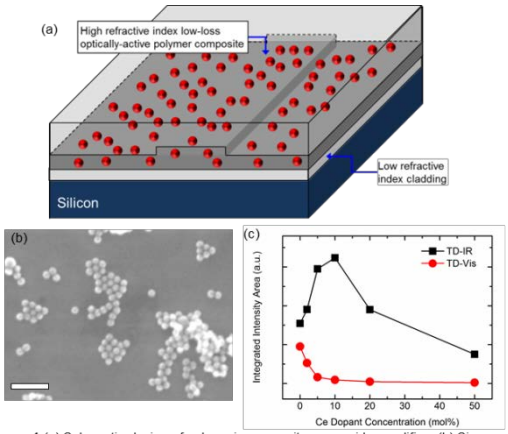

Figure 1 (a) Schematic design of polymeric composite waveguide amplifier, (b) Size distribution of as-synthesized infrared emitting nanoparticles and (c) Quenched visible and enhanced infrared emissions by optimizing dopant chemistry.

References

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