Nanocomposites and nanomaterials

Nanoparticles effects on spectral-luminescent and generation properties of polymer laser media based on organic dyes

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Polymer matrix based systems with different inclusions attract great attention of researchers due to the fundamental scientific interest and their potential applications in many fields of techniques, in particular, in laser technologies.

Composite materials with monomer and aggregated forms of laser dyes in the aromatic polyurethane acrylate polymer doped with silicon dioxide nanoparticles were investigated experimentally in this work. The studies concerned spectral, photophysical and generation properties of rhodamine and pyrromethene dyes in this polymer matrix. The synthesis method was developed to prevent silicon dioxide agglomerations in the initial mixture and during polymerization process, in order to obtain homogeneously dispersed nanoparticles.

Large concentrations (~ $2x10^{-2}$ mol/l) of rhodamines in aromatic polyurethane acrylate cause the presence not only a monomer form of the dyes, but also different associations, namely, dimers, trimers and J-aggregates. Nanoparticles lower the aggregation tendency of dye molecules, since their doping to the aromatic polyurethane acrylate increases significantly dielectrical permittivity of the polymer, and thus result in the photostability growth of organic dyes in this material. Stability increase of the dyes is also caused by the smaller free volume in the nanoparticle-doped elastic polymer, which hinders collisions of dye molecules with reactive elements (singlet oxygen, radicals, etc.). SiO_2 nanoparticle inclusion to the polymer matrix increases luminescence intensity of the dyes, and consequently, results in larger generation efficiency of dye lasers.

In summary, new composite optical polymer materials based on elastic aromatic polyurethane acrylate with silicon dioxide nanoparticles were proposed. Their structure and properties were found to make them promising for the development of efficient solid-state active media for tunable organic lasers.

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