Investigating the angle-dependent emission of dye-doped 3D luminescent opals: optical property insights

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Streszczenie

This study explores the synthesis protocol and examines the optical properties of dye-doped poly(methyl methacrylate) (PMMA) spheres, self-assembled into 3D colloidal photonic crystals. Utilizing a variety of luminescent dyes (POPOP, coumarin 6, DPP derivative, and DCM), emitting across the visible spectrum, this research proposes the incorporation of these dyes into PMMA spheres at the stage of the synthesis and use of the latter to produce luminescent 3D opals. The results of the study, which include comprehensive photoluminescence characterization, including quantum yield (QY) determination and angle-dependent emission analysis, provide a deep understanding of the integration process and the resulting photophysical properties. In addition, the effect of the dye addition on the size of the spheres and their monodispersity was evaluated. A careful choice of dyes and synthesis conditions in this study resulted in obtaining the materials that exhibit angle-dependent emission in different spectral ranges, demonstrating the versatility of the synthesis approach. Adjusting the sphere size to match specific dye emission wavelengths enabled the effective alignment of photonic band gap positions with the emission spectra, resulting in emission color shifts with the viewing angle. These findings significantly contribute to the advancement of the design of functional materials with tailored optical properties. Moreover, the results highlight the potential of these materials for advanced optical applications, particularly in anti-counterfeiting material technologies, and provide a versatile approach to designing materials with tunable optical properties.