Tailoring Coumarin Derivatives for Advanced Nanoscale Imaging and Photoinitiated Nanolithography

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Abstract

The advancement of super-resolution techniques such as Stimulated Emission Depletion (STED) microscopy demands the development of structurally diverse and photostable fluorophores with tailored excitation and emission properties. In this study, a series of coumarin-based compounds were rationally designed, synthesized, and characterized to serve dual functions as fluorescent probes and photoinitiators. Coumarins were selected due to their well-documented photophysical tunability, high quantum yields, and established utility in radical photopolymerization. The compounds were subjected to comprehensive optical characterization, including UV-Vis absorption, fluorescence emission spectroscopy, and lifetime measurements, to assess their suitability for STED imaging. Additionally, their performance as photoinitiators under light-induced polymerization conditions was evaluated. The resulting structure–property relationships suggest promising applicability in both super-resolution nanoscopy and high-precision nanolithography, offering a platform for multifunctional molecular tools in nanoscale science and fabrication.

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