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PERSISTENT LUMINESCENCE AND NIR TO VISIBLE UPCONVERSION FROM HYBRID MATERIAL FOR BIOIMAGING APPLICATIONS

York E. Serge Correales,[1] Marco A. Teodoro da Silva,[1] Henrique L. Piva,[2] Antonio C. Tedesco,[2] Robert Mauricot,[3] David Neumeyer,[3] Marc Verelst,[3] Sidney J. L. Ribeiro[4] and Rogéria R. Gonçalves[1]

[1]Laboratório de Materiais Luminescentes Micro e Nanoestruturados – Mater Lumen, Departamento de Química, Faculdade de Filosofia, Ciências e Letras de Ribeirão Preto, Ribeirão Preto-SP, Brazil
[2]Department of Chemistry, Center of Nanotechnology and Tissue Engineering-Photobiology and Photomedicine Research Group, Faculty of Philosophy, Sciences and Letters of Ribeirão Preto, University of São Paulo, Ribeirão Preto-SP, Brazil
[3]Univ Toulouse UPS, Centre d'Élaboration de Matériaux et d'Études Structurales (CEMES-CNRs), Toulouse, France
[4]Institute of Chemistry, São Paulo State University (UNESP), Araraquara-SP, Brazil
E-mail: york.correales@usp.br

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Lanthanide-based upconversion nanoparticles (Ln^{3+}-UCNPs) can convert near-infrared (NIR) photons into higher energy ultraviolet-visible (UV-Vis) light.[1] They are characterized by sharp luminescence peaks, long luminescence lifetimes and tunable luminescence emissions in the UV-Vis-NIR region.[1] Meanwhile, chromium-doped persistent luminescence nanoparticles (Cr^{3+}-PLNPs) function as "optical batteries", storing and slowly releasing energy post-excitation.[2] Their key features include intense and long-lasting NIR emission and versatile photoexcitation capabilities.[2] These properties contribute to minimal biological tissue damage, reduced autofluorescence signal, and deep penetration capability, making UCNPs and PLPs ideal for advanced biomedical fluorescence imaging.
The integration of Ln^{3+}-UCNPs and Cr^{3+}-PLNPs in a unified system offers NIR excitation and UV-Vis emission, accompanied by a long NIR afterglow. This synergy could reduce background interference and enable NIR reactivation. In this study, we detail the synthesis, surface modification, and coupling reaction between $NaYbF_4$:Tm^{3+}@$NaYF_4$ UCNPs and $ZnGa_2O_4$:Cr^{3+} PLNPs to obtain a UC-PL system that exhibits a NIR-based photoluminescent response. We additionally evaluated the cell viability and potential bioapplications of the synthesized Ln^{3+}-UCNPs and Cr^{3+}-PLNPs. Our UCNPs demonstrated strong UC luminescence, long luminescence lifetimes, and high UC efficiency. The PLNPs exhibited post-excitation emission for over a thousand seconds. In particular, the photons emitted by UCNPs enabled the photoactivation of PLNPs, resulting in the emission of NIR radiation for a reasonable duration post-excitation. Furthermore, both types of nanoparticles exhibited excellent colloidal stability in aqueous media and relatively low cytotoxicity to 3T3 cells after surface functionalization. Preliminary results also show potential for bioimaging applications, particularly in cell labeling.

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