



Discovering the potential of biomaterial-based mesoporous and magneto-luminescent nanohybrid (Nd-doped Hydroxyapatite/Fe₃O₄) for cancer theranosis

Multimodality nanoplatfoms play a crucial role in advancing medical interventions by integrating multiple functionalities into a single system. However, issues like intricate production processes and biocompatibility persist. Herein, a facile synthesis of a biomaterial-based mesoporous nanocarrier, HAp:Nd+SPIONs@mSiO₂, loaded with the near-infrared (NIR) emitting dye indocyanine green (ICG) is reported. HAp:Nd nanoparticles were synthesized via combustion methods. Thereafter, commercial SPIONs and HAp:Nd were integrated within a mesoporous silica via a modified Stöber approach. HAp:Nd+SPIONs@mSiO₂ nanoplatfom was characterized for particle size, porosity, and luminescence using TEM, BET, and luminescence spectroscopy. The synthesized nanoplatfom was further loaded with ICG dye and the loading efficiency was analyzed via UV-Vis spectroscopy. Photonic and magnetic thermal heating of the ICG-loaded nanoplatfom was also analyzed along with the photo-stimulated ROS generation ability. Finally, cytotoxicity and therapeutic analysis was performed in vitro. The nanohybrid with ~100 nm average size, comprised of Nd-doped hydroxyapatite (HAp), Fe₃O₄ superparamagnetic iron oxide nanoparticles (SPIONs), and mesoporous silica, exhibiting magneto-luminescent properties. The mesoporous structure was loaded with ICG as a model drug (4.3 µg/mg of nanoparticles) where a pH-dependent release was observed. The nanocarrier demonstrated dual functionality by generating heat through magnetic and photonic stimulation, as well as producing reactive oxygen species (ROS) upon excitation with 808 nm light. In vitro bioevaluation on aggressive triple-negative breast cancer cells (MDA-MB-231) showed the high biocompatibility of nanohybrid with and without ICG and exhibited significant toxicity after irradiation of NIR light. Noticeably, the nanohybrids also exhibit the ability to monitor temperature changes via Nd³⁺ associated NIR luminescence. The nanoplatfom integrates clinically relevant components, highlighting its potential for translation from the laboratory to clinical applications. The developed nanohybrids, with combined NIR-mediated photothermal and photodynamic effects, magnetic photothermal capabilities, and NIR/MR imaging, offer promise in addressing cancer heterogeneity and improving conventional treatments with reduced side effects.

Keywords

luminescent materials, cancer theranostics, biomaterial, photodynamic therapy, magnetic hyperthermia

Reference

Corresponding author's email address: prakharsengar@ens.cnyn.unam.mx, hirata@ens.cnyn.unam.mx

P. Sengar, K. Chauhan, and G.A. Hirata, Progress on carbon dots and hydroxyapatite based biocompatible luminescent nanomaterials for cancer theranostics, *Transl Oncol* 24 (2022) 101482. <https://doi.org/10.1016/J.TRANON.2022.101482>.

This work was supported by

DGAPA-UNAM (Grant IN-113823 and IA-201124) and the Consejo Nacional de Ciencia y Tecnología CONACyT-México (Grant CB-284548). Dr. Prakhar Sengar gratefully acknowledges CONACyT for the postdoctoral fellowship.

Author approval

I confirm

Author will attend

I confirm

Primary authors: Dr HIRATA, Gustavo (Physicochemistry of Nanomaterials. Center of Nanoscience and Nanotechnology, Autonomous University of Mexico, Km 107 Carretera Tijuana –Ensenada Apdo Postal 14, CP. 22800 Ensenada, BC. México.); Dr SENGAR, Prakhar (Centro de Nanociencias y Nanotecnología, Universidad Nacional Autónoma de México Ensenada, Baja California, México, C.P. 22860)

Co-authors: Dr RODRÍGUEZ HERNÁNDEZ, Ana (Centro de Nanociencias y Nanotecnología, Universidad Nacional Autónoma de México Ensenada, Baja California, México, C.P. 22860); Dr CHAUHAN, Kanchan (Centro de Nanociencias y Nanotecnología, Universidad Nacional Autónoma de México Ensenada, Baja California, México, C.P. 22860)

Presenter: Dr SENGAR, Prakhar (Centro de Nanociencias y Nanotecnología, Universidad Nacional Autónoma de México Ensenada, Baja California, México, C.P. 22860)

Session Classification: LUMINESCENCE PHENOMENA

Track Classification: Luminescence Phenomena: Materials and Applications