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Theranostic nanoparticles for cancer treatment with enhanced fluorescence and singlet oxygen generation

Amit Nag

BITS Pilani University, India

Theranostic nanomedicine has the potential to revolutionise the future disease management on the detection and treatment of cancer using photodynamic therapy (PDT) agents. Photosensitizer (PS) with bright fluorescence is attractive for image-guided PDT due to its dual functional role in Singlet Oxygen Generation (SOG) and producing high fluorescence signals. But, traditional PSs are very weakly fluorescent. In this presentation, Red-emitting carbon nanoparticles, produced by an economical and green hydrothermal method using Eucalyptus leaves, will be demonstarted for the first time for Chemo-PDT combination therapy after conjugating with the anticancer drug mitoxantrone electrostatically.1 The synthesized nanoparticles exhibited severel important features, including red emission (λem ≈ 680 nm), significant quantum yield (15%), low cytotoxicity, and extraordinary 1O2 quantum yield (96% under irradiation by 660 nm laser). On the other hand, plasmonic nanomaterials have demonstrated tremendous research outcome due to their excellent and unique optical properties. Noble metal nanostructures have the ability to confine incident radiation and generate massive amount of electromagnetic field in their neighborhood, which can enhance the Fluorescence signals of analyte molecules near to the surface, leading to the phenomenon of Metal-Enhanced Fluorescence (MEF). For better cancer treatment, it is crucial to develop brightly fluorescent photosensitizer using MEF with efficient metal-enhanced singlet oxygen generation (ME-SOG) upon light irradiation. Along this line, a library of novel theranostic nanoparticle systems for personalized medicine PDT are prepared using Ag and Au nanoparticles.2 Metal-enhanced fluorescence and singlet oxygen generation (SOG) studies are performed for a naphthalene-linked pyridine-based neutral triarylethene as AIE-active PS molecule, by adsorbing on the Ag and Au core-shell nanoparticles. The best result, 7.9 fold enhancement in fluorescence and 10.4-fold enhancement in SOG, is observed on loading AIEgen on □42 nm Au nanoparticles with polymer spacer, showing promising advancement for image-guided PDT. The obtained results from the study has the potential to replace or support the conventional radiation therapy and chemotherapy with serious adverse effects.

Biography

Amit Nag is an Associate Professor in Chemistry, at BITS-Pilani Hyderabad Campus. He received his Ph.D. in 2009 from IIT Kanpur, India under the supervision of Professor Debabrata Goswami on femtosecond laser chemistry. He worked as a Post-doctoral fellow at the University of California, Irvine, U.S.A with Professor Ara Apkarian on scan-probe microscopy and at the Department Chemie und CeNS, LMU, Munich, Germany with Professor Achim Hartschuh on plasmonics and Tip-Enhanced Raman Spectroscopy. He has successfully completed sponsored projects funded by BITS-Pilani, DST and CSIR. His research interests include Nonlinear laser spectroscopy, Scanning-probe microscopy, Plasmonics, Carbon Dots, Biophysical chemistry.