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Plasmonic nanostars: A golden platform for medical diagnostics and photo immunotherapy

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An overview of recent developments in our laboratory for plasmonics-active gold nanostars (GNS) have been developed and applied for multifunctional cancer diagnostics and therapy (theranostics) will be provided. Plasmonics refers to the research area of enhanced electromagnetic properties of metallic nanostructures that produce ultrasensitive and selective detection technologies. The technology involves interactions of laser radiation with metallic nanoparticles, inducing very strong enhancement of the electromagnetic field on the surface of the nanoparticles. These processes, often called 'plasmonic enhancements', produce the surface-enhanced Raman scattering (SERS) effect that could enhance the Raman signal of molecules on these nanoparticles more than a million-fold. The SERS technology can be used to directly detect chemical species and biological species with exquisite sensitivity for biomedical diagnostics.

A SERS-based nanoprobe technology, referred to as 'Molecular Sentinel' nanoprobes, has been developed to detect DNA targets of pathogenic agents (e.g., HIV) and biomarkers of diseases (e.g., BRCA1, ERB2 breast cancer genes). Other plasmonic platforms, such as gold nanostars, offer plasmon properties that efficiently transduce photon energy into heat for photothermal therapy. Nanostars, with their small core size and multiple long thin branches, exhibit intense two-photon luminescence, and high absorption cross sections that are tunable in the near infrared region with relatively low scattering effect, rendering them efficient efficient photothermal agents in cancer therapy. A theranostic nanoplatform construct was created, allowing SERS imaging and photodynamic therapy. SERS-based plasmonic nanoprobes and nanochip systems have also been developed for use as diagnostic systems for point-of-care personalized nanomedicine and global health applications.

Gold nanostars can be used for photothermal therapy and immunotherapy. GNS- mediated photothermal therapy combined with checkpoint immunotherapy —a treatment we referred to as Synergistic Immuno Photothermal Nanotherapy (SYMPHONY)— has been found to reverse tumor-mediated immunosuppression, leading to the treatment of not only primary tumors but also cancer metastasis as well as inducing long-lasting immunity, i.e. an anti-tumor 'vaccine' effect in murine model.

Speaker Biography

Tuan Vo-Dinh is a distinguished Professor of Biomedical Engineering, Professor of Chemistry, and Director of the Fitzpatrick Institute for Photonics. His research activities and interests involve biophotonics, nanophotonics, plasmonics, laser-excited luminescence spectroscopy, room temperature phosphorimetry, synchronous luminescence spectroscopy, surface-enhanced Raman spectroscopy, field environmental instrumentation, fiber optics sensors, nanosensors, biosensors and biochips for the protection of the environment and the improvement of human health.

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