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Plasmonics nanoprobes: A new generation of biotools for cellular sensing, biomedical imaging and bioenergy research

There is a strong need to develop nanoprobes for cellular sensing and imaging, which allow selective and sensitive monitoring of bio-targets and molecular processes inside and outside cellular systems related to studies of plant bio-systems relevant to biofuel production. We develop a new class of nanoprobes called inverse molecular sentinels (iMS) for nucleic acid targets (e.g., mRNAs, microRNAs, siRNAs) that will enable imaging and study of cellular functions, both in plant and microbial species using surface-enhanced Raman scattering (SERS) detection. The iMS nano-probe system is composed of three parts: A stem-loop nucleic acid probe labeled with a Raman reporter, which provides the source of the Raman signal; a plasmonic-active nanoparticle e.g. nanospheres or nano-stars and; an unlabeled capture placeholder strand. Upon exposure to the target sequences, the placeholder capture strand leaves the "open" stem-loop probe, allows the stem-loop to "close" and moves the Raman label onto the plasmonics-active metal surface; this yields a strong SERS signal. The multiplex capability of SERS is an important feature due to the narrow Raman bandwidths, which provides significant advantages over other methods. We demonstrate the multiplexing capability of the iMS technique to target *RGA* and *PP2AA3* genes of plant cells. *RGA* gene belongs to a 5-gene DELLA family *in Arabidopsis*, which plays a critical role in controlling plant biomass. The results of this study demonstrate the feasibility of using the iMS nanoprobes for multiplex detection of important markers in bioenergy-relevant plant systems. The results obtained with the iMS sensing technology will be useful to understand and manipulate vegetative plant growth by identifying and ultimately modulating DELLA expression in specific cell types. Because DELLAs play a central role in regulating vegetative growth in flowering plants, our work will provide significant insights into novel ways to manipulate plant growth to increase biomass if renewable energy sources are for a sustainable and green future.

Biography

Tuan Vo-Dinh is a Professor of Biomedical Engineering, Professor of Chemistry, and Director of Fitzpatrick Institute for Photonics at Duke University. He completed his BS in Physics in 1970 at École Polytechnique Fédérale de Lausanne (EPFL) in Lausanne, Switzerland, and PhD in Physical Chemistry in 1975 at ETH (Swiss Federal Institute of Technology) in Zurich, Switzerland. His research activities involve "Nanophotonics, biophotonics, nano-biosensors, biochips, molecular spectroscopy, bioimaging for medical diagnostics and therapy (nano-theranostics), personalized medicine and global health". He has received seven R&D 100 Awards for most technologically significant advance in research and development for his pioneering research and inventions of innovative technologies. He has received Gold Medal Award, Society for Applied Spectroscopy (1988); the Languedoc-Roussillon Award (France) (1989); the Scientist of the Year Award, ORNL (1992); the Thomas Jefferson Award, Martin Marietta Corporation (1992); two Awards for Excellence in Technology Transfer, Federal Laboratory Consortium (1995, 1986) etc. He has authored over 400 publications in peer-reviewed scientific journals.

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