Standalone, Multifunctional All-Optical Nanosensors

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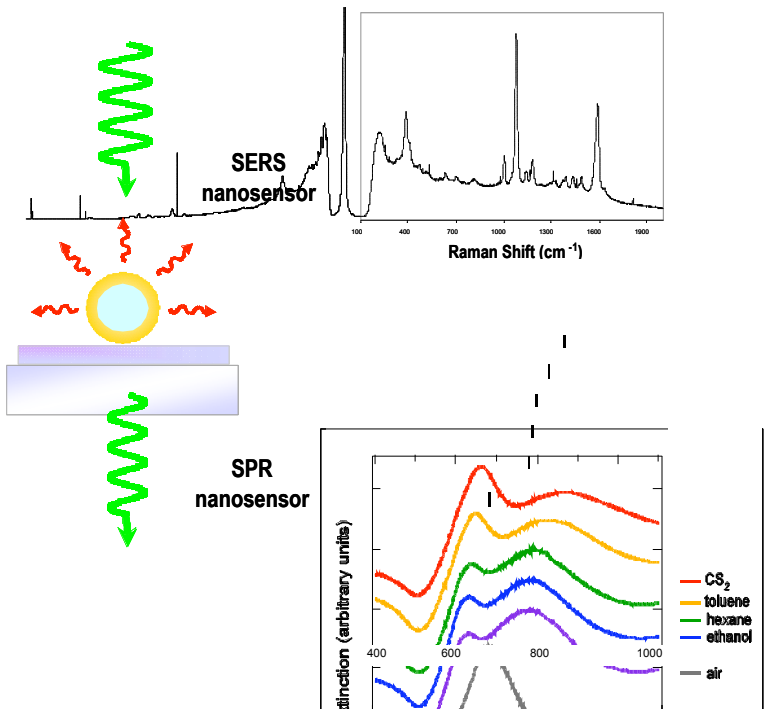
PIs: Naomi J. Halas[1,3], Peter J. Nordlander[1,2], Bruce Johnson[3] and Jeffrey Hartgerink[3]

Department of Electrical and Computer Engineering[1], Department of Physics[2], Department of Chemistry[3], Rice University, Houston, TX

Nanoshells provide an ideal geometry for chemical sensing in two ways. First, by capturing and focusing light to high intensities at their surface, nanoshells can be designed to enhance and sensitize chemical spectroscopies in a highly controllable and optimizable manner. This "nanolens" effect allows individual nanoshells to probe their local chemical environment with unprecedented sensitivity and detail, as a noninvasive, all-optical chemical nanosensor. Nanoshells also respond sensitively to changes in their local chemical and dielectric environment through changes in their optical resonance. This property, known as surface plasmon resonance (SPR) sensing, is effectively miniaturized to nanoscale dimensions using the nanoshell core-shell geometry.

We have optimized the nanoshell geometry for both chemical and SPR nanosensing, developing the first multifunctional, standalone, all-optical nanosensor. Unprecedented enhancements of greater than 10^{10} of the chemical signature of molecules have been achieved, the largest enhancements reported to date for individual nanoparticle substrates. We have also recently performed a study of the geometrical factors that optimize the nanoshell geometry for greatest sensitivity to changes in its dielectric environment, essentially designing the optimal nanoshell surface plasmon resonant (SPR) nanosensor. Ultimately, this multifunctional nanosensor can be utilized to probe the local internal and external environments of living cells in real time.



A multifunctional all-optical nanosensor based on the nanoshell geometry.

[1] J. B. Jackson and N. J. Halas, Proceedings of the National Academy of Sciences, in press.
[2] F. Tam, C. Moran, and N. J. Halas, Journal of Physical Chemistry B 108, 12790-12794 (2004).