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Enhanced nonlinear optics and other applications of resonant plasmonics

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A surface plasmon polariton is the result of a photon coupling to a collective charge excitation in an electron gas. It is the optical equivalent of ordinary electrical currents at lower frequencies. By this analogy, just as regular electronic circuits can have resonances at discrete frequencies, metal nanostructures can exhibit plasmonic resonances in the optical frequency regime. These resonances tend to concentrate the electromagnetic field intensity by several orders of magnitude within nanometer scale hotspots located at sharp corners or inside narrow gaps in the structure. This phenomenon can be used to enhance a number of different effects, such as Raman scattering, fluorescence efficiency and photochemical reactions. This talk will give an overview of some of our recent work in this area, focusing on using plasmons to enhance the second harmonic generation (SHG) from nonlinear optical films. In particular, we have shown that the addition of plasmonic nanoparticles to such a film can increase the SHG emission as much as 2000 times. We have applied this idea to SHG generation in tapered optical fiber, where we obtain quasi-phase matching by patterning the deposition of metal nanoparticles onto the otherwise uniform nonlinear film that coats the fiber. I will also discuss our recent work on plasmonically enhanced nonlinear microscopy and plasmon enhanced photovotaics.

In collaboration with Kai Chen, Chih-Yu Jao, Chalongrat Daengngam, Jeong-Ah Lee, and J. Randall Heflin, VirginiaTech, Department of Physics; Sungsool Wi, VirginiaTech, Department of Chemistry; Lauren Neely, Vladimir Kochergin, MicroXact, Inc.; and Yong Xu, Virginia Tech, Department of Electrical and Computer Engineering.