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Novel Plasmonic and Hyperbolic Optical Materials for control of Quantum Nanoemitters

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Final Report

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Final Report

Project Title: Cross Discipline Research on Hyperbolic Optical Systems for Control of Quantum Nanoemitters.

Objective: The proposed cross-discipline experimental study aims to combine diamond color center emission properties, metal ion implantation techniques, and multi-physics modeling to produce hyperbolic quantum nanoemitters.

During the course of this project we studied plasmonic interactions in a composite material consisting of an anisotropic array of gold nanorod clusters doped to a polyvinyl alcohol (PVA) film. Using the Z-scan technique with an excitation source at 800 nm and 100 fsec pulses, we showed that giant plasmonic field induced by resonant excitation of the aligned gold nanorod clusters in a mechanically stretched polyvinyl alcohol (PVA) film results in 57-fold enhancement of nonlinear absorption. The saturation of both nonlinear absorption and nonlinear refraction was also observed. Numerical simulations of the local electric field enhancement due to the clustering of the gold nanorods in PVA matrix showed a remarkable agreement with the measured nonlinear absorption coefficient enhancement. Our results are quantitatively consistent with models of local field enhancement within the clusters, and thus, our work provides a rationale for the morphological design of optical nanocomposites with ultra-high plasmonic nonlinearities.

Publications:

1. M. Maldonado, H.T.M.C.M. Baltar, A.S.L. Gomes, R. Vaia, K. Park, J. Che, M. Hsiao, C.B. de Araújo, A. Baev, and P.N. Prasad, "Coupled-Plasmon induced optical nonlinearities in anisotropic arrays of gold nanorod clusters supported in a polymeric film," *J. Appl. Phys.* **2016** [under revision].