Electric-Field-Induced Second-Harmonic Generation in Serrated Nanogap Arrays

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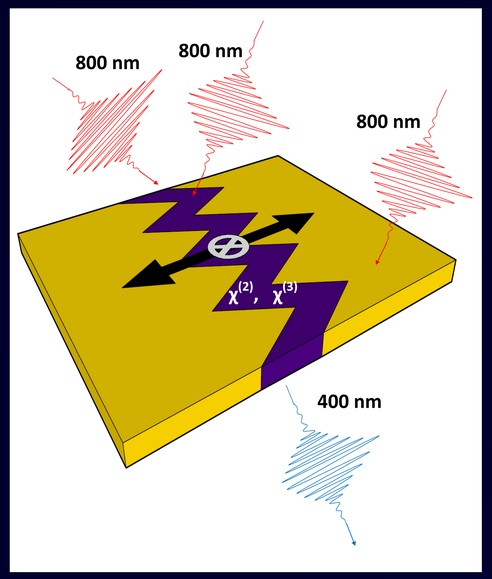
Introduction

Plasmonic nanoparticles can be used to generate and control the spatial distribution of electric fields at the nanoscale in order to efficiently generate second-harmonic light. Electric-field-induced second-harmonic generation (EFISH) allows for the optical modulation of second-harmonic light using an external, applied electric field. Our objective was to fabricate serrated, gold nanogap arrays and to demonstrate that they could produce second harmonic generation. Additionally, we sought to study the change in the SHG efficiency after filling the gap with PMMA to study changes in the second order polarizability of the material.

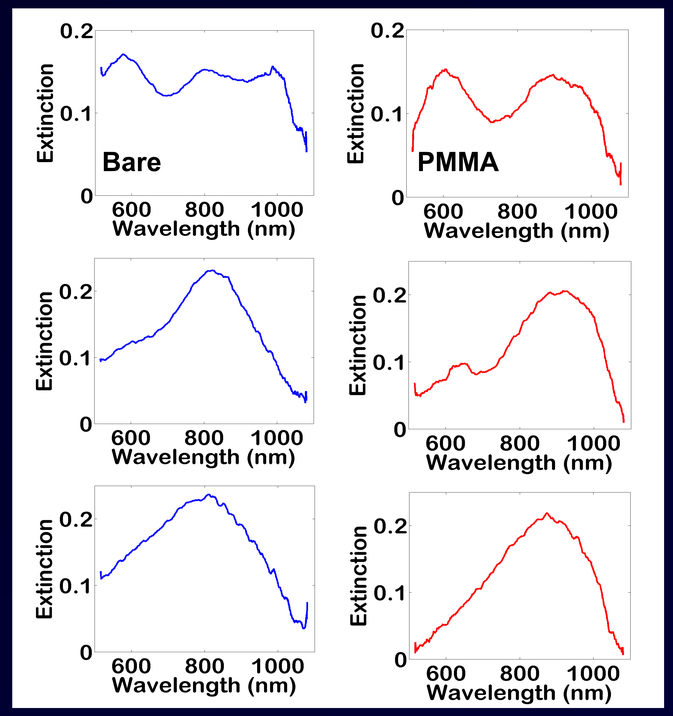
Plasmonic Geometry

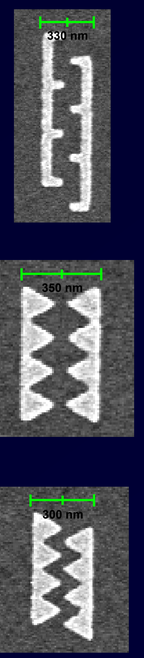
- Centro or non-centro symmetric dielectric
- Electric field gradient from plasmon
- Polarization of the dielectric material
- EFISH generated from dielectric
- Three-photon process
- Nanogaps fabricated using e-beam lithography



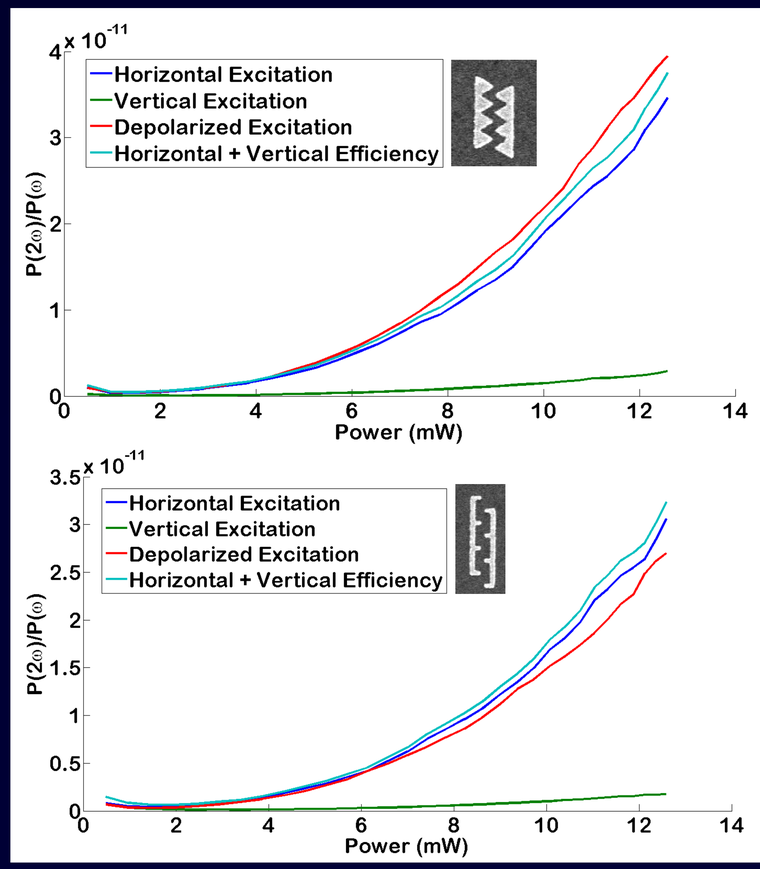
Serrated Nanogap Arrays

Extinction Spectra

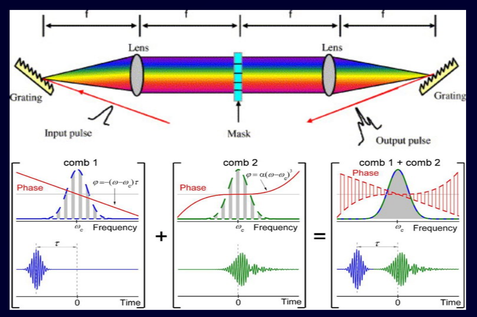




EFISH (PMMA)



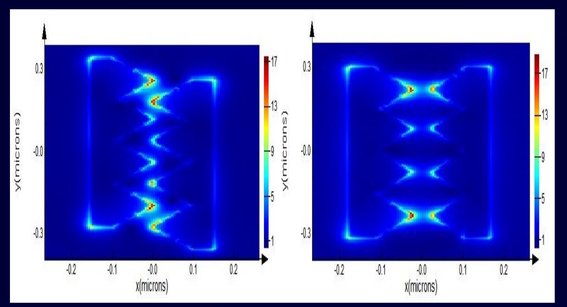
Spatial Light Modulator



- Beam compression (~20 fs)
- Polarization rotation
- Multiple pulse generation
- Ti:Sapphire 800 nm pulses

Electric Field Gradient

- FDTD simulation of electric field structure on the surface of the nanoparticle
- Vertical electric field gradient



Conclusions

- Fabricated novel asymmetric gold nanogaps
- Demonstrated that they produced SHG with a conversion efficiency on the order of 10^{-11}
- Saw SHG enhancement in geometry with sharp electric field gradient in response to depolarized, incident light
- Future experiments planned with Si, Si_3N_4, SiO_2, GaAs, and $BaTiO_3$
- Relation between the polarization of the incoming pulse and the produced SHG will be explored

Acknowledgements

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Brongersma, Mark L. "Electrically Controlled Nonlinear Generation of Light with Plasmonics". *Science* **333**, 1720 (2011).