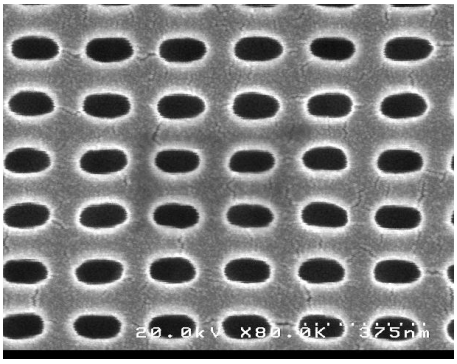
Scientific Accomplishments: Nanoelectronics ILIR (FY08) and Nanomaterials for Broadband Energy Conversion DA-ILIR (FY09)

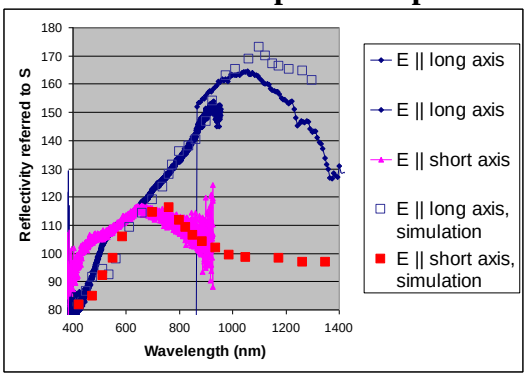
Nanoantenna Arrays with Visible/Near-infrared Resonances

Advances in nanotechnology have allowed researchers to develop arrays of nanoscale islands, which have interesting optical properties that can be engineered over desired wavelength ranges. This resonant behavior is accompanied by an enhancement of the local electromagnetic field, which is useful for sensing applications. Because their resonances can be selectively tuned, these nanoscale islands are often termed "nanoantennas". The nanoantenna array's resonance depends on the nanoantenna's geometry, distance to other nanoantennas, and material (usually highly conductive metals like gold, silver, etc.). The US Army Natick Soldier RDEC (NSRDEC) is researching nanoantenna arrays that resonate in the visible/near-infrared (vis/nir) portion of the electromagnetic spectrum. Nanoantenna arrays that resonate at visible frequencies are very challenging to fabricate; electrons in metals oscillate collectively in localized surface plasmon modes, and the individual nanoantennas must be much smaller than the resonance wavelength, especially if the nanoantenna array is immersed in a polymer, which moves the resonance even further towards the infrared. Hence, the nanoantennas must have very small dimensions < 100 nm. We have designed nanoantenna arrays to resonate in the blue-green when immersed in a polymer, and we fabricated the first generation of such a nanoantenna array on silicon, using high-resolution electron-beam patterning at NSRDEC and the Army Research Laboratory. The resonance of this successful, first generation NSRDEC array agrees well with modeling predictions, giving us confidence to predict performance of future nanoantenna arrays, and opens the door for future nanoantennas that resonate throughout the vis/nir spectrum, enabling new applications of nanotechnology to vis/nir detectors, energy conversion, etc.

First generation nanoantenna array



Measured and predicted performance



R. M. Osgood III, G. F. Walsh, D. Ziegler, J. B. Carlson, L. E. Belton, and B. R. Kimball, "Nanoantennas with short wavelength resonance", in **Plasmonics: Metallic Nanostructures and Their Optical Properties VI**. Edited by Mark I. Stockman, Proceedings of the SPIE, Volume 7032, pp. 703206-703210 (2008).

Contributing Agency: DoD/AMC/NSRDEC