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ENZ Plasmonics

Nader Engheta

H. Nedwill Ramsey Professor
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In this talk, I will discuss the merging of two phenomena, the extreme-parameter metamaterials with the plasmonic optics. It is well known that the surface plasmon polaritons (SPP) in plasmonic structures possess apparent wavelengths along the metallic interfaces that are shorter than the free space wavelength. In the field of metamaterials, materials with extreme values for relative permittivities (or permeability), e.g., epsilon-near-zero (ENZ) materials exhibit refractive index being near zero, resulting in essentially uniform phase and very long apparent wavelengths in such media. We have been interested in exploring the merging of these two seemingly opposite features, by combining ENZ metamaterials with the SPP waves in plasmonic optics. We have been developing and exploring fundamental concepts and various potential applications of extreme-parameter plasmonic metamaterials. We have shown ENZ-based enhanced transmission through ultranarrow channels and bends with arbitrary shapes and forms, we have theoretically studied enhancement of molecular emission near ENZ-inspired plasmonic structures, and confinement of highly intense electric field in a channel. We have also investigated how ENZ materials manipulate the phase patterns of beams. In this talk, I will give an overview of this ENZ-based plasmonics, and will discuss exciting potentials and future ideas and possibilities.

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SF1101, Sandford Fleming Building

Winner of the 2012 IEEE Electromagnetics Award, Nader Engheta is the H. Nedwill Ramsey Professor at the University of Pennsylvania with affiliations in the Departments of Electrical and Systems Engineering, Bioengineering, and Physics and Astronomy. He received his B.S. degree from the University of Tehran, and his M.S and Ph.D. degrees from Caltech. Selected as one of the *Scientific American Magazine 50 Leaders in Science and Technology* in 2006 for developing the concept of optical lumped nanocircuits, he is a Guggenheim Fellow, an IEEE Third Millennium Medalist, a Fellow of IEEE, American Physical Society (APS), Optical Society of America (OSA), American Association for the Advancement of Science (AAAS), and SPIE-The International Society for Optical Engineering, and the recipient of the 2008 *George H. Heilmeier Award for Excellence in Research*, the *Fulbright Naples Chair Award*, *NSF Presidential Young Investigator award*, the *UPS Foundation Distinguished Educator term Chair*, and several teaching awards including the *Christian F. and Mary R. Lindback Foundation Award, S. Reid Warren, Jr. Award* and *W. M. Keck Foundation Award*. His current research activities span a broad range of areas including metamaterials and plasmonics, nanooptics and nanophotonics, biologically-inspired sensing and imaging, miniaturized antennas and nanoantennas, physics and reverse-engineering of polarization vision in nature, mathematics of fractional operators, and physics of fields and waves phenomena. He has co-edited (with R. W. Ziolkowski) the book entitled "*Metamaterials: Physics and Engineering Explorations*" by Wiley-IEEE Press, 2006. He was the Chair of the Gordon Research Conference on Plasmonics in June 2012.

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