Reconfigurable Infrared Metamaterials

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BIOGRAPHY

Dr. Koray Aydin is an Assistant Professor in the Electrical Engineering and Computer Science Department at Northwestern University and leading the Metamaterials and Nanophotonic Devices Laboratory. He has received his B.S. and Ph.D. degrees in Physics from the Bilkent University in 2002 and 2008, respectively. During his PhD, he studied novel electromagnetic phenomena, such as negative refraction, subwavelength imaging, and enhanced transmission, in microwave metamaterials and photonic crystals. He has worked as a postdoctoral researcher between 2008-2010 and a research scientist between 2010-2011 at the California Institute of Technology under the supervision of Prof. Harry Atwater. Dr. Aydin's postdoctoral research has focused on the experimental and theoretical investigation of active optical metamaterials and functional plasmonic nanostructures. Dr. Aydin also served as the first Assistant Director for the Light-Material Interactions Energy Frontier Research Center in 2011. His research interests are in the general area of nanophotonics, with a specific focus towards the realization of nanophotonic devices for use in energy conversion, defense and health applications. Dr. Aydin is the recipient of the SPIE Educational Scholarship in 2007.

TECHNICAL ABSTRACT

Nanophotonics, the emerging field of photon-material interactions at the nanoscale, poses many challenges and opportunities for researchers engineering devices with subwavelength features. Plasmonic nanostructures and metamaterials exhibit optical properties not seen in conventional photonic materials and enable focusing, guiding, bending, and absorbing photons at the nanoscale. They are poised to revolutionize a broad range of applications including energy and sensing.

In this talk, I will describe the design, nanofabrication and optical characterization of engineered nanophotonic materials that enable controlled and enhanced photonic functionalities. First, I will discuss flexible, stretchable metamaterials in which the mechanical actuation of flexible polymers can be used to control the nanoscale distances between coupled metallic resonators. Such reconfigurable, smart metaphotonic materials significantly enhance the infrared reflection signal from a C-H vibrational mode, could find use in bio-chemical sensing and environmental screening applications. We observed 180-fold increase in the sensitivity of infrared absorption detection. As a second application of optical metamaterials we will discuss broadband light-trapping approaches enabled by the unique design of optical metamaterials. Ultrathin, polarization-insensitive, broadband metamaterial super absorbers capable of absorbing light over the entire visible spectrum will be discussed in detail. These uniquely shaped plasmonic nanostructures could be utilized in solar energy conversion applications for efficient light-trapping and photon management in photovoltaic and thermophotovoltaic cells.

Keywords: metamaterials, plasmonics, nanophotonics, IR filters, biosensing, photovoltaics

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