UCLA ENGINEERING
Henry Samueli School of Engineering and Applied Science
Electrical Engineering Department

Ph.D. Defense

Large-Area Plasmonic Photoconductive Nanoantenna Arrays for Terahertz Wave Generation and Detection in High-Performance Time-Domain Terahertz Systems

Nezih Tolga Yardimci

Advisor: Prof. Mona Jarrahi

Tuesday, May 9, 2017, 1:00 p.m. – 3:00 p.m.
Eng. IV Bldg., Tesla Room, #53-125

Abstract: Time-domain terahertz imaging and spectroscopy systems have unique functionalities for chemical identification, material characterization, biological sensing, medical imaging, and security screening. Photoconductive sources and detectors are commonly used for the generation and detection of terahertz pulses in compact time-domain terahertz systems operating at room temperature. However, the low radiation power of conventional photoconductive sources and the low responsivity of conventional photoconductive detectors have limited the scope of the potential uses of these systems. To improve the performance of time-domain terahertz systems, photoconductive sources and detectors consisting of large-area plasmonic nanoantenna arrays are designed, fabricated and experimentally characterized.

To increase the radiation power of photoconductive sources, the plasmonic nanoantenna arrays are designed to enhance the absorption of optical pump photons near them. The enhanced optical absorption leads to stronger ultrafast photocurrent levels coupled to the nanoantenna arrays. The nanoantenna arrays are designed to serve as broadband terahertz radiating elements. Hence, high-power and broadband pulsed terahertz radiation is generated. Higher terahertz radiation powers and device efficiencies are achieved by a tighter optical pump confinement enabled by plasmonic nanocavities formed near the plasmonic nanoantenna arrays. Record-high terahertz radiation powers as high as 4 mW are achieved over a 0.1 – 5 THz frequency range.

To increase the responsivity of photoconductive detectors, the plasmonic nanoantenna arrays are designed to maximize the interaction between the optical pump photons and the incident terahertz radiation at the nanoscale. The impact of the nanoantenna geometry on terahertz detection responsivity and bandwidth is analyzed theoretically and experimentally. By optimizing the geometry of the nanoantenna arrays, broadband time-domain terahertz spectroscopy with a record-high dynamic range of 107 dB is demonstrated.

Biography: Nezih Tolga Yardimci is currently a Ph.D. candidate in the Electrical Engineering Department at UCLA. He received his B.S. degree from Middle East Technical University in 2012 and M.S. degree from University of Michigan in 2014. The outcome of his research appeared in five first-author journal publications, 22 conference proceedings and one keynote talk. Throughout his Ph.D. study, he received prestigious awards including Henry Samueli School of Engineering Fellowship, SPIE Scholarship in Optics and Photonics and Best Student Paper Award (3rd Place) in International Conference of International Society of Infrared, Millimeter and Terahertz Waves.

For more information, contact Prof. Mona Jarrahi (mjarrahi@ee.ucla.edu)