New Frontiers in Terahertz Devices and Systems

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Abstract:
Terahertz waves exhibit various unique features for chemical identification, material characterization, biological sensing, and medical imaging. However, the relatively poor performance, higher costs, and bulky nature of currently existing terahertz systems continue to impede their deployment in field settings. In this talk, I will introduce a new class of optoelectronic devices based on plasmonic nanostructures that allow terahertz wave generation and detection with several orders of magnitude higher radiation powers and detections sensitivities compared to the state-of-the-art. I will detail how we have utilized the unique potentials of these plasmonic devices to demonstrate efficient optical-to-terahertz conversion with record-high conversion efficiencies as high as 7.5%, record-high-sensitivity terahertz detection with signal-to-noise ratios exceeding 107dB, and record-high-power terahertz generation with mW-level output powers. The capabilities of these plasmonic optoelectronic devices are further extended to develop terahertz imaging, spectroscopy, and spectrometry systems with significantly better performance compared to the state-of-the-art. For this purpose, we have developed novel reconfigurable metasurfaces that can be integrated with plasmonic terahertz sources and detectors to manipulate the spectral and spatial characteristics of terahertz waves. To achieve these significant advances, the plasmonic optoelectronic devices are integrated with various on-chip optical sources and optimized for operation at telecommunication wavelengths, where high power, wavelength tunable, compact and cost-effective optical sources are commercially available. These results pave the way to compact and low-cost terahertz imaging, spectroscopy, and spectrometry systems with numerous applications in e.g., medical imaging and diagnostics, atmospheric sensing, sustainable water management, pharmaceutical quality control, and security screening.

Biography:
Mona Jarrahi received her Ph.D. degree in Electrical Engineering from Stanford University and is currently an Associate Professor of Electrical Engineering at UCLA and the director of Terahertz Electronics Laboratory. Her research is focused on ultrafast optoelectronic devices and systems for terahertz/millimeter-wave sensing, imaging, and communication. She has >160 publications in leading journals and conference proceedings of her field and gave >130 invited talks in various meetings. Dr. Jarrahi's scientific achievements have been recognized by several major awards including the Presidential Early Career Award for Scientists and Engineers; Friedrich Wilhelm Bessel Research Award from Alexander von Humboldt Foundation; Moore Inventor Fellowship from Gordon and Betty Moore Foundation; Kavli Fellowship by National Academy of Sciences, Grainger Foundation Frontiers of Engineering Award from National Academy of Engineering; Breakthrough Award from Popular Mechanics Magazine; Early Career Award in Nanotechnology from IEEE Nanotechnology Council; Outstanding Young Engineer Award from IEEE Microwave Theory and Techniques Society; Booker Fellowship from National Committee of the International Union of Radio Science; Lot Shafai Mid-Career Distinguished Achievement Award from IEEE Antennas and Propagation Society; Early Career Award from National Science Foundation; Young Investigator Awards from Office of Naval Research, Army Research Office, and Defense Advanced Research Projects Agency; Elizabeth C. Crosby Research Award from University of Michigan and various best-paper awards at International Microwave Symposium, International Symposium on Antennas and Propagation, and International Conference on Infrared, Millimeter, and Terahertz Waves.