

University of California, Irvine

THE DEPARTMENT OF MATERIALS SCIENCE AND ENGINEERING

MSE 298 SEMINAR

FALL 2025: MSE IN THE SPOTLIGHT

**Professor
Howard Lee**
**Department of Physics
and Astronomy**



RESEARCH TALK: ***TUNABLE OPTICAL METASURFACES AND ZERO-INDEX MATERIALS***

SHORT CAREER TALK: ***SHARING OF MY ACADEMIC JOURNEY: PASSION AND OPPORTUNITIES***

Abstract: The ability to control flow of light is important for optical applications, leading to photonic technologies that significantly impact daily life, such as high-speed optical internet, ultrathin optical displays, novel lasers, and medical imaging tools. Over the last two decades of photonic science advances, the optical metamaterials and metasurfaces paradigm has revolutionized photonic matter design using nanoscale structures, yielding new optical properties and functions not found in natural materials. These ultrathin optical metasurfaces consist of arrays of subwavelength light scatterers (i.e., optical antennas), leading to unique control of light properties. Due to metasurfaces' planar, thin-film nature (typical thickness <100 nm), they can replace conventional bulky 3D optics and enable ultrathin optical components such as flat lenses, wave plates, and holographic surfaces over a broad spectral range, significantly impacting next-generation optical displays, communications, and consumer optoelectronic applications. While metasurfaces show exceptional promise, there are several limitations such as the lack of optical turnabilities of metasurfaces and the challenges on integrating functional metasurfaces into optical devices/systems, etc.

In this talk, I will give an overview of our research efforts on electrically and nonlinear optically tunable metasurfaces and zero-index optical materials for developing new active optical applications. I will present our recent advances on the use of transparent conducting oxide and conducting polymer materials to demonstrate electrically-tunable ultrathin optical metasurfaces that can tune the optical phase and amplitude for light steering and nonlinear/quantum emission control. In addition, strongly enhanced optical nonlinearity of nano-engineered conducting oxide epsilon-near-zero (ENZ) meta-film will be discussed [4-8]. Recent developments of 2D ITO and neural network designed ENZ materials will be presented. I will then discuss our study on a new type of "meta"-optical fiber which merges the sciences of optical metasurfaces and optical fibers, leading to the development of ultrathin optical meta-optical fiber probe for potential medical imaging endoscope and laser surgery applications. These advanced "meta"-optics open the path to novel in-fiber lasers/spectroscopies, optical imaging/sensing, and optical/quantum communication applications.

Bio: Howard Lee is currently a Professor in the Department of Physics and Astronomy at UC Irvine. Before joining UCI in 2020, he was an Associated Professor in the Department of Physics at Baylor University and IQSE Fellow and visiting professor in the Institute for Quantum Science and Engineering (IQSE) at TexasA&M. He was a Postdoctoral Fellow at the Caltech, working with Prof. Harry Atwater in active plasmonics/metasurfaces. He received his PhD in Physics from the Max Planck Institute for the Science of Light in Germany in 2012 under the supervision of Prof. Philip Russell. His work on nano-optics, plasmonics/metasurfaces, and photonic crystals has led to publications in various journals, such as Science, Nano Letters, and Advanced Materials, as well as 100 invited talks and 200 conference papers. Dr. Lee is a recipient of a 2025 Optica Fellow, a 2025 Moore Experimental Physics Investigator, a 2025 IEEE Photonics Society Distinguished Lecturer, a 2024 SPIE Fellow, a 2023/2022 Finalist of Moore Inventor Fellow, a 2023 UCI Beall Innovation Award in Physical Sciences, a 2022 iCANX Young Scientist Award, 2021 Finalist of Rising Stars of Light, 2020 SPIE Rising Researcher, a 2020 Baylor Outstanding Professor Award, a 2019 DARPA Director's Fellowship, a 2019 IEEE OGC Young Scientist Award, a 2018 NSF CAREER Award, a 2017 DARPA Young Faculty Award, a 2018 OSA Ambassador, and a 2017 APS Robert S. Hyer Award. He has strong passion in promoting optical sciences and physics to students and the general public, and in serving for the professional communities. He organized more than 25 technical sessions in nanophotonics/metasurfaces in international conferences (Optica, META, PQE, MRS, IEEE) and serves as Lead Symposium Organizer for plasmonic/metasurface symposiums at 2019-2025 MRS Fall Meeting and 2020-2026 MRS Spring Meeting (organized > 2000 presentations). He is 2025 Vice Chair for APS Far West Section. He was Founding Associate Editor for OSA Continuum and currently serves as Associate Editor for Scientific Reports and Photonics journals. He is a Fellow of Optica and SPIE.

DATE: Thursday, December 4, 2025

TIME: 2:00 - 3:20 PM

**LOCATION: McDonnell Douglas Engineering
Auditorium**