Theoretical and Physical Chemistry Institute
National Hellenic Research Foundation
Vass. Constantinou 48, Athens

ONLINE LECTURE

“Artificial and natural sheet materials for photonic applications”

Dr. Odysseas Tsilipakos

Institute of Electronic Structure and Laser,
Foundation for Research and Technology – Hellas,
and
Dept. of Materials Science & Technology,
University of Crete,
Heraklion, Crete
Greece

Monday, July 18, 2022, 12:00

Link: Click here to join the lecture
Passcode: 238693

Artificial and natural sheet materials for photonic applications

Odysseas Tsilipakos

Institute of Electronic Structure and Laser, Foundation for Research and Technology – Hellas, Heraklion, Crete, Greece
Dept. of Materials Science & Technology, University of Crete, Heraklion, Crete, Greece

Metasurfaces, artificial ultrathin materials composed of subwavelength resonant building blocks (meta-atoms), promise to replace bulky conventional diffractive and dispersive optical components, offering significant technological advantages (size & weight reduction, planar fabrication) and the ability to tailor their response at will by engineering the underlying meta-atoms. However, due to the inherent resonant nature, their response is typically narrowband limiting their practical potential. I will discuss how metasurfaces with *multiresonant* unit cells can overcome this limitation and be made to exhibit arbitrarily broadband (achromatic) response. This will be demonstrated by examples of broadband pulse delay without distortion [1], and achromatic wavefront manipulation (beam steering) [2]. The proposed concept has been experimentally verified in GHz frequencies by a subwavelength multiresonant unit cell comprising five resonant meta-atoms [3].
Natural 2D photonic materials are being investigated for a broad range of photonic and optoelectronic applications. Graphene, the most prominent representative, exhibits strong third-order nonlinearity in THz and optical frequencies. I will discuss graphene-enhanced components for nonlinear applications, focusing on optical bistability (memory functionality) [4], four-wave mixing (frequency generation) [5] and saturable absorption (switching/routing) [6]. In addition, I will highlight the modifications to traditional theoretical frameworks required for studying nonlinear components incorporating 2D materials.

[1] *ACS Photonics* **5**, 1101 (2018); https://pubs.acs.org/doi/abs/10.1021/acsphotonics.7b01415

[2] *Advanced Optical Materials* **8**, 2000942 (2020); https://doi.org/10.1002/adom.202000942

[3] *ACS Photonics* **8**, 1649 (2021); https://doi.org/10.1021/acsphotonics.1c00025

[4] Journal of Applied Physics **122**, 233101 (2017); https://doi.org/10.1063/1.5005610

[5] *Physical Review B* **98**, 235421 (2018); https://doi.org/10.1103/PhysRevB.98.235421

[6] *Journal of Applied Physics* **131**, 053104 (2022); https://doi.org/10.1063/5.0076959