TERADAYS 2024

19-20 February

Napoli, Italy

Contribution ID : **10** Type : **not specified**

Infrared Plasmons in Quantum Materials

lunedì 19 febbraio 2024 10:40 (20)

Surface plasmons, the collective oscillations of electrons in metals and doped semiconductors, show outstanding electromagnetic (EM) properties spanning from a reduced wavelength in comparison to that of an exciting electromagnetic field, an extreme electric field enhancement several orders of magnitude larger than the incident field, to several nonlinear effects like harmonic generation and optical rectification. Although conventional metals, like gold and silver, are usually used in plasmonics, non-conventional and exotics materials now on the scientific edge, providing additional properties like plasmon tunability due to their extreme sensitivity to external parameters like doping, temperature, and electric and magnetic fields. In this work we present the generation of surface plasmon polariton in two quantum materials, patterned in the form of micro-ribbon arrays: the ultrahigh conductive PdCoO2 oxide and the Wey-II semimetal PtTe2. PdCoO2 layered delafossite is the most conductive compound among metallic-oxides, with a room-temperature resistivity of nearly 2 μΩcm, corresponding to a mean free path of about 600Å1. These values represent a record considering that the charge density of PdCoO2 is three times lower than copper [1]. PtTe2 is a Weyl semimetal, with topological nontrivial properties and the highest room-temperature electrical conductivity among metallic Transition Metal Dichalcogenides [2]. By changing the width W and period 2W of the ribbon arrays, we select suitable values of the plasmon wavevector q, experimentally sampling the surface plasmon dispersion (see Fig.1 for PdCoO2) in the mid-infrared electromagnetic region. Near the ribbon edge, we observe a strong field enhancement due to the plasmon confinement, indicating both materials as a promising infrared plasmonic candidates [3,4].

[1] Brahlek, M. et al. Growth of metallic delafossite PdCoO2 by molecular beam epitaxy. Phys. Rev. Mat. 3, 093401 (2019). [2] Hao, S. et al. Low-Temperature Eutectic Synthesis of PtTe2 with Weak Antilocalization and Controlled Layer Thinning Adv. Funct. Mater., 28, 1803746 (2018). [3] Macis, S. et al., Infrared Plasmons in Ultrahigh Conductive PdCoO2 Metallic Oxide. Communications Physics, 5(1), 1-6, (2022). [4] Macis, S. et al. Terahertz and Infrared Plasmon Polaritons in PtTe2 Type-II Dirac Topological Semimetal Nature Communications, submitted (2023).

Primary author(s) : MACIS, Salvatore (Sapienza University); MOSESSO, Lorenzo (Sapienza, University of Rome, Department of Physics); TOMARCHIO, Luca (Sapienza University); LUPI, Stefano (Sapienza, University, Department of Physics)

Presenter(s) : MACIS, Salvatore (Sapienza University)

Session Classification : I session