THz polaritons in 2D materials investigated by near-field nanoscopy

Eva A. A. Pogna

[a] *Istituto di Fotonica e Nanotecnologie, CNR-IFN, 20133 Milano, IT*

Corresponding author email: evaariannaaurelia.pogna@cnr.it

Polaritons are hybrid light-matter excitations which offer unique possibilities for nanoscale control of electromagnetic (e.m.) radiation, especially for terahertz (THz) fields which have long free-space wavelengths, in the range 30 μm to 3mm. The polaritons of strongly anisotropic layered two-dimensional materials, are emerging for achieving enhanced control over the propagation direction.

Here, the propagation of THz plasmon polaritons in hBN-encapsulated black phosphorus is mapped in real-space by photocurrent nanoscopy [1-2]. Black phosphorus is an orthorhombic biaxial crystal with interesting plasmonic and optoelectronic applications in the THz range [4-5]. The observed plasmon polaritons support record-high THz subwavelength field confinement and show elliptic propagation wavefront [3]. The tunability of the plasmon polaritons is demonstrated by electrostatic control of the carrier density, using field-effect transistors (FETs), and by varying the thickness of the bottom hBN.

The tunable directional confinement of THz light attained with bP anticipates promising applications in sensing, nonlinear optics and waveguiding. While the photoelectrical detection directly suggests possible on-chip functionalities exploiting the observed THz polaritons.

The four-gate FET geometry that is here proposed allows for direction-resolved detection of polariton propagation and can be applied for investigating the in-plane anisotropy of alternative van der Waals materials, overcoming the intrinsic limitation of the s-SNOM techniques, which preferably couple out-of-plane field polarization.

References

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