Magnetoplasmons in monolayer black phosphorus structures

Two-dimensional materials supporting deep-subwavelength plasmonic modes can also exhibit strong magneto-optical responses. Here, we theoretically investigate magnetoplasmons (MPs) in monolayer black phosphorus (BP) structures under moderate static magnetic fields. We consider three different structures, namely, a continuous BP monolayer, an edge formed by a semi-infinite sheet, and finally, a triangular wedge configuration. Each of these structures shows strongly anisotropic magneto-optical responses induced both by the external magnetic field and by the intrinsic anisotropy of the BP lattice. Starting from the magneto-optical conductivity of a single layer of BP, we derive the dispersion relation of the MPs in the considered geometries, using a combination of analytical, semi-analytical, and numerical methods. We fully characterize the MP dispersions and the properties of the corresponding field distributions, and we show that these structures sustain strongly anisotropic subwavelength modes that are highly tunable. Our results demonstrate that MPs in monolayer BP, with its inherent lattice anisotropy as well as magnetically induced anisotropy, hold potential for tunable anisotropic materials operating below the diffraction limit, thereby paving the way for tailored nanophotonic devices at the nanoscale.

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