Nanophotonics with van der Waals magnets

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Abstract

Layered magnetic materials have recently attracted intensive studies of their unique properties opening access to novel physics of magnetism in the low dimensional limit [1]. An attractive prospect in magnetism is achieving control of magnetic properties via coupling to light [2, 3]. To facilitate such control, photonic structures supporting resonant optical modes may be an attractive solution. Here, we fabricate nanoantennas made from thin films of high-refractive-index antiferromagnetic semiconductors $NiPS_3$, $MnPSe_3$ and $MnPS_3$ [3] and demonstrate their Mie resonances tunable by the nanoantenna size. By utilizing van der Waals forces typical for layered materials, we were able to fabricate such nanoantennas on gold substrates, where, due to high reflectivity of gold, we observed notable narrowing of Mie resonances. Nanoantennas on gold substrates were fabricated by mechanical exfoliation of thin (20-400 nm) films of $NiPS_3$, $MnPSe_3$ and $MnPS_3$, followed by electron-beam lithography, and reactive ion etching. Figure 1 shows the bright field optical image (a), the dark-field image (b), and SEM (c) of a $NiPS_3$ nanoantenna array. We observed the tuning Mie resonance by changing the antenna radius [Figure 1 (d)]. Our fabrication approach provides a way for enhancing light-matter interaction in a wide range of materials classes including magnets, dielectrics and semiconductors, as well as potentially superconductors and metals existing in the layered crystal form.

References

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Figures

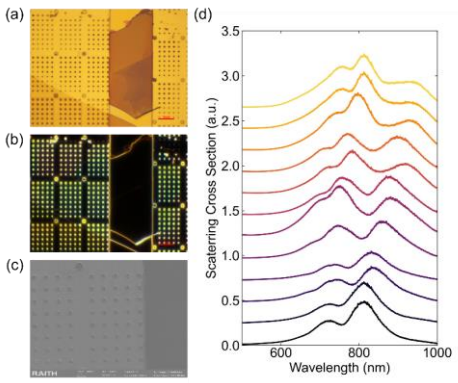

Figure 1: $NiPS_3$ magnetic nanoantenna on gold. (a) Bright field and (b) dark field optical images. (c) SEM image. (d) Dark-field scattering spectra.