**Extreme nanophotonics based on surface polaritons in two-dimensional materials**

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Two-dimensional (2D) materials have been the focus of intense research owing to their potential for a variety of nanophotonic applications, including light sources, metasurfaces, and photodetectors. Weak light-matter interactions have been attributed as a fundamental bottleneck in improving the performances of the nanophotonic devices based on 2D materials. Until now, a number of approaches based on silicon waveguides, microcavities, and plasmonic antennas have been suggested to enhance the light-matter interactions in 2D materials harnessing the physical overlap between 2D materials and near-field hot spots generated by the photonic devices. In this case, still, only a small fraction of incident light can interact with 2D materials since the mode volume of near-field hot spots is significantly larger than the physical volume of a 2D material layer. Surface polaritons, a result of strong coupling of photons with electrons, phonons, and excitons, have potential to overcome this fundamental limitation due to their extreme level of field confinement. On the other hand, the extreme field confinement comes at the expense of a coupling efficiency due to the significant momentum mismatch with far-field radiation.

In this presentation, we present how this fundamental trade-off between the field confinement and the coupling efficiency of surface polaritons in 2D materials can be overcome. Based on the highly efficient coupling mechanism, we have demonstrated a polaritonic resonator platform that can be applied to any types of polariton-supporting 2D materials to simultaneously achieve extreme field confinement and near-unity coupling efficiency. Our resonator platform can benefit fundamental studies of general polariton physics as well as nonlinear and nonlocal effect and will have strong impact on various infrared applications such as photodetectors, metasurfaces, light-emitting devices, and optical modulators.

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