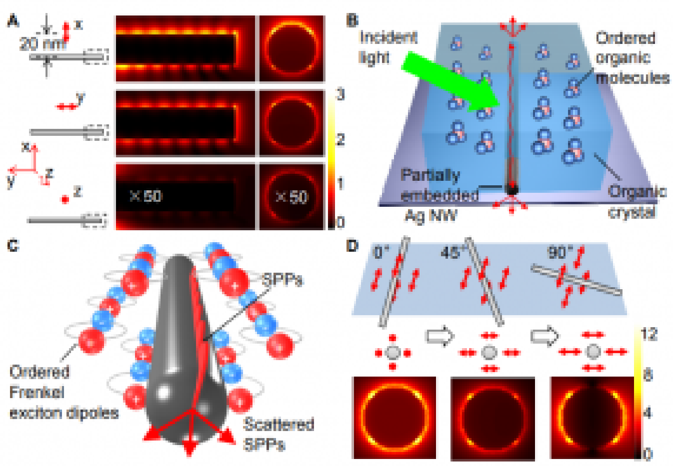
Orientation-Dependent Exciton-Plasmon Coupling in Embedded Organic/Metal Nanowire Heterostructures



Organic/metal nanowire heterostructures for the study of orientation dependent exciton-plasmon coupling. (A) Numerically simulated $|E|^2$ distribution of SPPs at the end of a 200-nm-diameter and 6 μm-long AgNW, where SPPs are launched by a dipole oriented along three coordinate axes x, y, and z, respectively. The dipole is positioned at the middle of the wire with a distance of 20 nm. (B) Schematic illustration for the proposed heterostructure with orderly arranged molecules around a partially embedded AgNW. (C) Oriented Frenkel typeexciton dipoles created around the AgNW by irradiation of an incident light at the junction. SPPs can be efficiently launched by the exciton dipoles, which will subsequently propagate along the AgNW and scatter into free space at the distal ends. (D) SPPs coupling by multiple exciton dipoles. The cross angle between the AgNW and the polarization of dipoles are 0°, 45° and 90°.

The excitation of surface plasmons by optical emitters based on exciton-plasmon coupling is important for plasmonic devices with active optical properties. It has been theoretically demonstrated that the orientation of exciton dipole can significantly influence the coupling strength, yet systematic study of the coupling process in nanostructures is still hindered by the lack of proper material systems. In this work, researchers have experimentally investigated the orientation-dependent exciton-plasmon coupling in a rationally designed organic/metal nanowire heterostructure system. The heterostructures were prepared by inserting silver nanowires into crystalline organic waveguides during the self-assembly of dye molecules. Structures with different exciton orientations exhibited varying coupling efficiencies. The near-field exciton-plasmon coupling facilitates the design of nanophotonic devices based on the directional surface plasmon polariton propagations.

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