Optical Metasurface for the Creation and Applications of Surface Plasmon Vortices

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Optical vortices are waves carrying orbital angular momentum and exhibit helical phase fronts. Helical phase front leads to discontinuous azimuthal phase jumps and the number of phase discontinuities (abrupt phase jumps from $-\pi$ to π) within a 2π range is referred to as the topological charge of an optical vortex. Optical vortices have been applied in trapping and spinning of microparticles, and recently in free-space data transmission. Generation of optical beams carrying orbital angular momentum has received increasing attentions recently, both in the far-field and in the near-field. Near-field vortices are typically generated through the excitation of surface plasmons (SP). However, the intensity patterns of the SP vortices generated thus far, just like the free-space vortex beams, are all azimuthally symmetrical (annular) since mathematically they conform to the Bessel function.

In this talk, I will first introduce our recent progress on spatial shaping the near-field spatial patterns of surface plasmon vortices. Moreover, in all past studies, SP vortices were excited by far-field circularly polarized light. This means the functionality of the SP devices were merely converting the far-field spin angular momentum to orbital angular momentum in the near-field. In the second part, I will focus on the creation of surface plasmon vortex using non-angular momentum excitation. In the last part, the application of surface plasmon vortex for particle trapping and rotation will be presented.

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