Gap and channeled plasmons in tapered grooves: a review

Tapered metallic grooves have been shown to support plasmons - electromagnetically coupled oscillations of free electrons at metal-dielectric interfaces - across a variety of configurations and V-like profiles. Such plasmons may be divided into two categories: gap-surface plasmons (GSPs) that are confined laterally between the tapered groove sidewalls and propagate either along the groove axis or normal to the planar surface, and channeled plasmon polaritons (CPPs) that occupy the tapered groove profile and propagate exclusively along the groove axis. Both GSPs and CPPs exhibit an assortment of unique properties that are highly suited to a broad range of cutting-edge nanoplasmonic technologies, including ultracompact photonic circuits, quantum-optics components, enhanced lab-on-a-chip devices, efficient light-absorbing surfaces and advanced optical filters, while additionally affording a niche platform to explore the fundamental science of plasmon excitations and their interactions. In this Review, we provide a research status update of plasmons in tapered grooves, starting with a presentation of the theory and important features of GSPs and CPPs, and follow with an overview of the broad range of applications they enable or improve. We cover the techniques that can fabricate tapered groove structures, in particular highlighting wafer-scale production methods, and outline the various photon- and electron-based approaches that can be used to launch and study GSPs and CPPs. We conclude with a discussion of the challenges that remain for further developing plasmonic tapered-groove devices, and consider the future directions offered by this select yet potentially far-reaching topic area.

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