Extremely confined gap surface-plasmon modes excited by electrons.

High-spatial and energy resolution electron energy-loss spectroscopy (EELS) can be used for detailed characterization of localized and propagating surface-plasmon excitations in metal nanostructures, giving insight into fundamental physical phenomena and various plasmonic effects. Here, applying EELS to ultra-sharp convex grooves in gold, we directly probe extremely confined gap surface-plasmon (GSP) modes excited by swift electrons in nanometre-wide gaps. We reveal the resonance behaviour associated with the excitation of the antisymmetric GSP mode for extremely small gap widths, down to ~5 nm. We argue that excitation of this mode, featuring very strong absorption, has a crucial role in experimental realizations of non-resonant light absorption by ultra-sharp convex grooves with fabrication-induced asymmetry. The occurrence of the antisymmetric GSP mode along with the fundamental GSP mode exploited in plasmonic waveguides with extreme light confinement is a very important factor that should be taken into account in the design of nanoplasmonic circuits and devices.

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