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Polarization-selective plasmon nanomodulator based on a phase change

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Manipulating optical signals at length scales below the diffraction limit is crucial for next- generation data-storage and telecommunication technologies. Although guiding light around sharply-bent waveguides of appropriately small dimensions was achieved a decade ago, modulating optical signals at terahertz frequencies in nanoscale volumes remains a challenge. Since the physics underlying any modulator relies on changes in dielectric properties, modulators based on strongly electron-correlated materials (SECMs) are attractive because they exhibit orders of magnitude changes in electrical and optical properties with modest thermal, electrical or optical triggers. Here we demonstrate a hybrid nanomodulator of deep sub-wavelength dimensions by spatially confining light on the nanometer scale using a plasmonic gold nanodisk while simultaneously controlling the reactive near-field environment at its optical focus with a single, precisely positioned SECM nanostructure, a vanadium dioxide nanodisk. Since the functionality of the nanomodulator hinges on the near-field electromagnetic interaction between the two nanodisks, the modulation is polarization-selective; moreover, the energy costs per unit switching contrast are extremely low. This architecture suggests shows that reconfigurable optoelectronic building blocks can be tailored with exquisite precision by varying size, geometry, and the intrinsic materials properties of the hybrid elements.