# Plasmonic infrared sensors with high sensitivity and specificity

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Nanoengineering can be used to control material properties at the macroscopic scale. We demonstrate utilising plasmonic resonance to tune the effective electrical conductivity of nanostructured vanadium oxide/dioxide thin films. Infrared sensors based on these thin films show controllable sensitivity and high wavelength specificity.

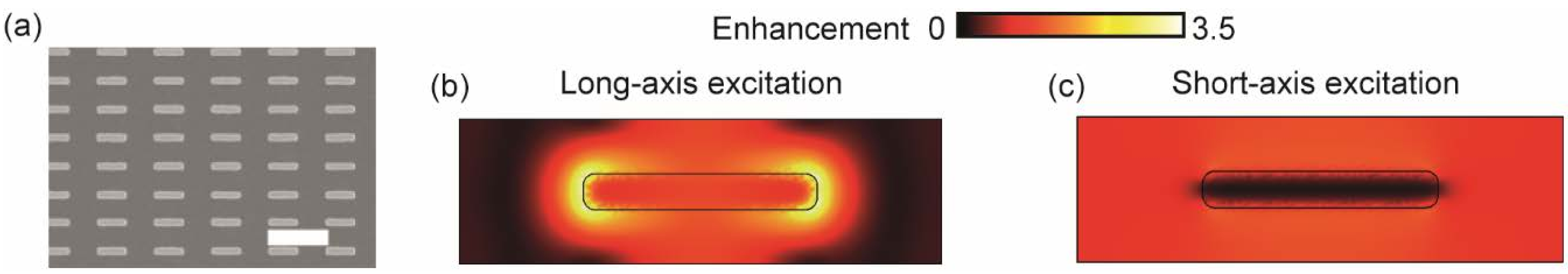


*Fig. 1. Sensor morphology and plasmonic resonance. (a) An array of metal nanorods. The scale bar is 1 μm. (b) Electric field distribution of a 2D plane located 10 nm above the nanorod top surface. Field strength is normalised against the value at the same location with the rod removed. The strong enhancement at the two ends of the rod is induced by plasmonic resonance. (c) At the same wavelength, such enhancement disappears if the light polarisation is rotated by 90 degrees. Comparable enhancement is, however, observable at a different wavelength.*

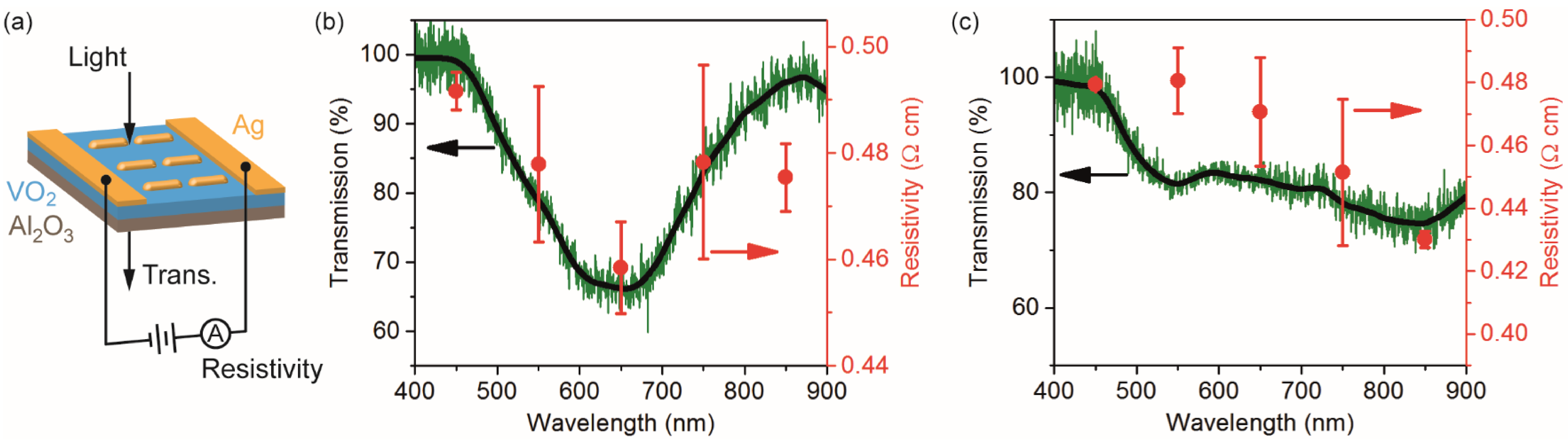


*Fig. 2. Infrared detector and its performance. (a) Detector schematic. (b) Experimentally measured optical transmission and wavelength dependent resistivity of the sample. The resistivity traces the transmission in changing the wavelength, showing the influence of plasmonic resonance on light detection. (c) The performance of the same detector changes in rotating the light polarisation, following the change of the plasmonic resonance.*

- Plasmonic nanorods convert light into heat, consequently suppressing the resistivity of vanadium dioxide via localised surface plasmon resonance.
- Incorporation of this thermo-plasmonic effect into bolometric photodetection allows for wavelength and polarisation sensitivity.

Further development in theory and experiment:

- We have utilised plasmonic resonance to control the effective phase transition temperature of vanadium oxide, demonstrating a new method of controlling phase transition through thermo-plasmonic engineering at the nanoscale.
- We have developed a modified Maxwell Garnett effective medium model for analysing electromagnetic hysteresis in phase change materials including vanadium dioxide. The model is easy to use, requires very few input parameters, and provides a phenomenological approach to describing electromagnetic hysteresis.

References:
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