Plasmonic nanoantennas for nanometer, picosecond control of VO_2 phase-transition

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Efficient and reversible switching of plasmonic modes at Vis and NIR wavelengths is one of the key desirable properties for optoelectronic devices. Phase-transition materials offer technologically relevant opportunities by providing notable changes in their dielectric response [1]. Vanadium dioxide (VO_2) is characterized by an insulator-to-metal transition at around 68°C [2]. In this work, we show how resonant pumping allows to use Au nanoantennas (NAs) fabricated on top of high-quality VO_2 films as a catalyzer for achieving ultrafast, highly localized VO_2 phase-transition [3]. Optical experiments demonstrate picosecond all-optical switching of the local phase transition in plasmonic NA-VO2 hybrids, exploiting strong resonant field enhancement and selective optical pumping in plasmonic hot-spots (Figure 1). The antena-assisted pumping mechanism is confirmed by numerical model calculations of the resonant, antenna-mediated local heating on a picosecond scale. Moreover, it is demonstrated that the phase transition mediated by local pumping of a plasmon resonance does not influence the resonance of a perpendicular NA positioned less than 100 nm away from the excited antenna. The NA-VO_2 hybrids enable new directions in all-optical ultrafast switching at picoJoule energy levels, and pave the way for plasmonic memristor-type devices exploiting nanoscale thermal memory.

References

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Figures

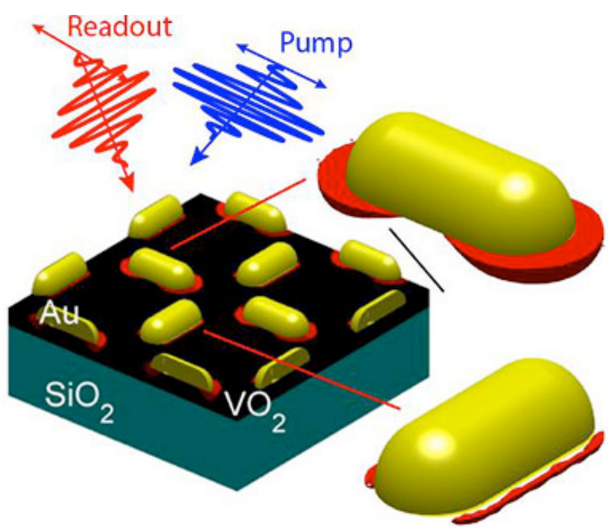

Figure 1: Pump-probe scheme of NA-VO_2 hybrids and simulated phase-switched hot-spots (red regions).