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Local probing of thermal energy transfer and conversion processes in VO2 nanostructures[1]

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Nanostructures of strongly correlated materials, such as metal-insulator transition (MIT) oxides, enable unusual coupling of charge and heat transport. Hence, they provide an interesting pathway to the development of non-linear thermal devices for active heat flux control. Here, we will report the characterization of local thermal non-equilibrium processes in vanadium dioxide (VO2) thin films and single-crystalline nanobeams. Using a scanning thermal microscope and calorimetric MEMS platforms, we studied the MIT triggered by electrical currents, electrical fields, near-field thermal radiation and thermal conduction. Based on out recently introduced scanning probe thermometry method, which enables direct imaging of local Joule and Peltier effects, we quantified self-heating processes in VO2 memristors using the tip of a resistively heated scanning probe both as local sensor and nanoscopic heat source. Finally, we will report on recent approaches to build radiative thermal switches and oscillators using VO2 nanostructures. We quantified variations of near-field radiative thermal transport between silicon dioxide and VO2 down to nanoscopic gap sizes, and will discuss its implications for the development of phonon polariton based radiative thermal devices.

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