Probing correlated electron matter by infrared nano-spectroscopy and nano-imaging

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One common attribute of several classes of correlated electron systems is that the insulator-to-metal transition in these systems typically occurs in the regime of nano-scale phase separation of chemical, and/or electronic/magnetic origin [1]. These intrinsic non-uniformities complicate the inquiry into the roles of lattice/structural transformations and many body physics in the emergence of metallicity. Despite rapid progress with the development of scanning probe techniques, it remains a challenging task to *simultaneously* probe nano-scale variations of electronic and structural properties over macroscopic regions [2]. We have accomplished this task using advanced nano-infrared methods that we have applied to investigate crystalline films of a prototypical correlated oxide VO_2. Recent experiments [3] have allowed us to visualize the route cause of the electronic anisotropy and memory effects [4] in this material. Through nano-spectroscopic monitoring of the lattice and free carrier dynamics in VO_2 we uncovered three different stages of the insulator-to-metal transition characterized by distinct electron-lattice effects.

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