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Ultrafast nano-imagining of the photoinduced phase transition dynamics in VO_2 SVEN A. DOENGES, OMAR KHATIB, BRIAN T. O'CALLAHAN, Department of Physics, Department of Chemistry, and JILA, University of Colorado, Boulder, CO 80309, JOANNA M. ATKIN, Department of Chemistry, University of North Carolina, Chapel Hill, NC 27514, JAE HYUNG PARK, DAVID H. COBDEN, Department of Physics, University of Washington, Seattle, WA 98195, MARKUS B. RASCHKE, Department of Physics, Department of Chemistry, and JILA, University of Colorado, Boulder, CO 80309 — Many quantum phase transitions in correlated matter exhibit spatial inhomogeneities with expected yet unexplored effects on the associated ultrafast dynamics. Here we demonstrate the combination of ultrafast non-degenerate pump-probe spectroscopy with scattering scanning near-field optical microscopy (*s*-SNOM) for ultrafast nano-imaging. In a femtosecond near-field non-degenerate near-IR (NIR) pump and mid-IR (MIR) probe experiment, we study the photoinduced insulator-to-metal (IMT) transition in nominally homogeneous VO_2 micro-crystals using far-from equilibrium excitation. We observe spatial heterogeneity on 50-100 nm length scales in the fluence dependent IMT dynamics, ranging from sub-100 fs to 1 ps. With pump fluences as high as nominally 10 mJ/cm^2 we can reach distinct excitation and saturation regimes. These results suggest a large sensitivity of the IMT with respect to local variations in strain, doping, or defects difficult to discern microscopically.

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