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Femtosecond Time-Resolved Nano-Imaging of the Insulator-to-Metal Transition in Vanadium Dioxide AARON STERNBACH, Columbia University Physics Department, KYLE LEWIS, PETER KISSIN, University of California, San Diego Physics Department, TETIANA SLUSAR, HYUN-TAK KIM, University of Science and Technology School of Advanced Device Technology, Metal-Insulator Transition Creative Research Center ETRI, RICHARD AVERITT, University of California, San Diego Physics Department, DIMITRI BASOV, Columbia University Physics Department — We have preformed femtosecond time-resolved and nanometer spatially resolved measurements of the insulator-to-metal transition in Vanadium Dioxide (VO_2). In order to make this work possible, we have devised and implemented a method for artifact-free nano-imaging with pulsed laser sources. We observe that the transient metallic state is highly inhomogeneous. Following an ultrafast pumping event, a homogeneous increase in near-field signal occurs, which signifies that the initial injection of conduction electrons is homogeneous. This is followed by the inhomogeneous insulator-to-metal transition, which evolves over two distinct timescales from tens to hundreds of picoseconds. Our advances pave a pathway to study a wide range of systems with inhomogeneities properties on the nanoscale with nanoscopic spatial, and ultrafast temporal resolution.

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