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Properties of Complex Oxides at the Nanoscale: First Order Phase Transitions through Avalanches.[1]

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Properties of complex oxides have been studied for decades, including many systems which exhibit a phase transition, among which are high temperature superconductors, multiferroics, and metal insulator (M-I) transition materials. We have studied a member of the later group, vanadium oxide (VO_2), which in spite of its long history, keeps surprising researchers today. We find that the M-I transition of nano-scaled VO_2 devices is drastically different from the smooth transition curves generally reported. The temperature driven M-I transition occurs through a series of resistance jumps ranging over two decades in magnitude, indicating that the transition between the two phases of the system happens by resistive avalanches. The avalanche magnitude follows statistically a power law similar to that observed in many other physical systems, such as Barkhausen noise in ferromagnets or sand avalanches in sand piles, and non-physical systems such as connectivity of the internet. We discuss the effects on the distribution of avalanches due to the: device dimensions, percolative nature of the measurement and interactions between the different phases within the phase transition. We present additional evidence for the importance of interactions in macroscopic FORC measurements, and their role in the opening of the hysteresis in VO_2 M-I transitions.

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