# Direct detection of nonthermal phase switching in a 1T-TaS2 memory device

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Transition metal dichalcogenide (TMDC) compounds attract great interest because of their strong electron-electron and electron-phonon interactions, resulting in a multitude of emerging states. Of particular interest for applications is the ability to rapidly switch between different states via charge injection. Uniquely, in the layered TMDC 1T-TaS2 a nonvolatile, reversible metallic hidden (H) state can be induced from the insulating equilibrium charge density wave (CDW) state by applying an optical or electrical pulse. As a step towards the development of a new type of ultrafast, nonvolatile cryomemory cells, we have investigated 1T-TaS2 by combining spatially-resolved micro-beam X-ray diffraction and fluorescence, as well as in-situ transport measurements at the Swiss Light Source synchrotron. This unique combination of techniques allowed us to spatially resolve the insultating equilibrium CDW order, and after electrical switching the induced, nonthermal H state. Our experiment reveals that the electrically and optically switched H states are not only electronically but also structurally equivalent. Furthermore, we find a bulk material switch in a narrow channel in-between the electrodes of the devices. This input regarding device design and operation paves the way for the application of 1T-TaS2 in memory technology.