Research Highlights

Observation of instabilities in metallic states for metal-to-insulator switch oxides

Vanadium dioxide (VO_2) shows a metal-to-insulator (MI) switch near room temperature (Fig. 1). Since switching phenomena near room temperature are rare, VO_2 has attracted attention for its switching mechanism, namely, the instability in the metallic state. Theoretical work on electronic structures of VO_2 40 years ago suggested that the instability is responsible for electron-phonon interaction [1]. Since then, much interest has been directed to experimental studies of electronic structures of VO_2 using angle-resolved photoemission electron spectroscopy (ARPES).

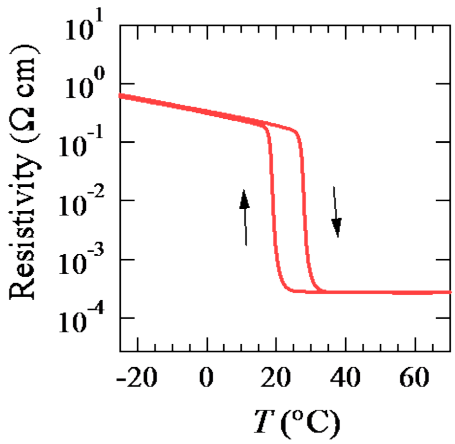

Fig. 1. Temperature dependence of the resistivity for a VO_2 epitaxial thin film on a $TiO_2(001)$ substrate.

However, ARPES measurements of VO_2 single crystals are difficult to perform because of the difficulty in obtaining a chemically stable cleavage plane in VO_2 single crystals with three-dimensional crystal structure.

Now, Yuji Muraoka and colleagues at Okayama University, High Energy Accelerator Research Organization, and University of Tokyo have determined the electronic structures of the metallic phase of VO_2 through studies of VO_2 epitaxial thin films grown on $TiO_2(001)$ substrates, using synchrotron radiation ARPES.

The electronic structures possessed a flat portion that is evidence for the presence of electron-phonon interaction predicted by theoretical work (Fig. 2).

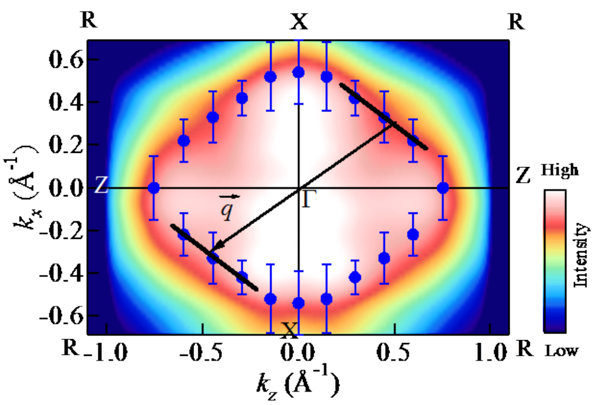

Fig.2. Electronic structure of a metallic phase of VO_2 epitaxial thin film on a $TiO_2(001)$ substrate. A flat portion is indicated with a black line.

The results obtained by Muraoka and colleagues strongly indicate the importance of electron-phonon interaction for the origin of the instability in the metallic state of VO2, and support the validity of theoretical work.

This research advances the understanding of the mechanism for the MI switch in VO_2, and provides fundamental knowledge for controlling the switching temperature for potential applications.

[1] M. Gupta, A. J. Freeman, and D. E. Ellis, Phys. Rev. B 16, 3338 (1977).

Reference:

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- Title of original paper: Fermi surface topology in a metallic phase of VO_2 thin films grown on TiO_2(001) substrates.
- Journal, volume, pages and year: Scientific Reports 8, 17906 (2018).
- Digital Object Identifier (DOI): 10.1038/s41598-018-36281-8
- Journal website: https://www.nature.com/articles/s41598-018-36281-8

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- Department website: http://www.science.okayama-u.ac.jp/~surface/index.html
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