The dependence of phase temperature on the planarly confined VO_2 structures

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VO_2 (vanadium dioxide), which is a strongly correlated metal dioxide, has the potential to be fabricated as a thermal trigger because of the characteristics of metal-insulator transition (MIT) around the room temperature. For thermal triggers, the tunable phase transition temperature expands device application scenarios. For VO_2 films, the lattice structure distortion caused by various substrates can reach the purpose of phase transition temperature modulation.[1] However, due to the inhomogeneous distribution of strain and defects, the phase transition process of large-scale films does not occur simultaneously, but is accompanied with the coexistence of metal domains and insulator domains.[2] The phenomenon is called phase separation. The investigation on planarly confined VO_2 samples is indispensable to identify the properties of domains.[3] In this research, in order to clarify the MIT behavior affected by the planarly confinement effect, the MIT process of VO_2 micron structures was systematically studied, and the phenomenon of the phase transition temperature change depending on the confined VO_2 structures size was found.

The VO_2 film, whose thickness is 15 nm, was epitaxially grown on a TiO_2 (001) substrate by pulsed laser deposition. The square channels with width (*w*) from 2 um to 10 um are prepared using photolithography and etching technology. As shown in the inset of Figure 1, the VO_2 micron-wire of 2 um width is clamped by a pair of electrodes. The MIT behavior was investigated by two-probe resistivity depending on the temperature change (*R-T*). Fig.1 shows the *R-T* curve of a VO_2 channel with w = 2 um. The steep stepwise resistivity changes, which indicates the appearance of the confinement effect, occurs around 275 K during both cooling and heating process.[4] To investigate the confinement effect quantitatively, the *R-T* curves were analyzed by the statistical transition model.[5] Figure 2 shows the estimated transition temperatures distribution of the VO_2 channels in the heating process. As the channel width increases from 2 um to 10 um, the phase transition temperature shows a totally upward trend from 268 K ~ 277 K to 276 K ~ 285 K. This result implies that the transition temperature was converted by virtues of the spatial confinement. In the presentation, we will show the details and discuss the mechanism.

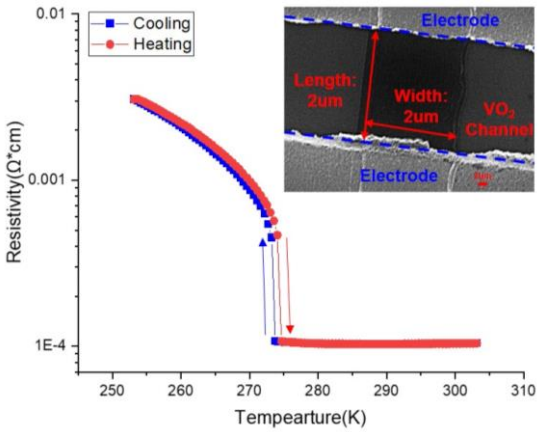

Fig.1 Typical *R-T* curves for the VO_2 channels with w = 2 um.

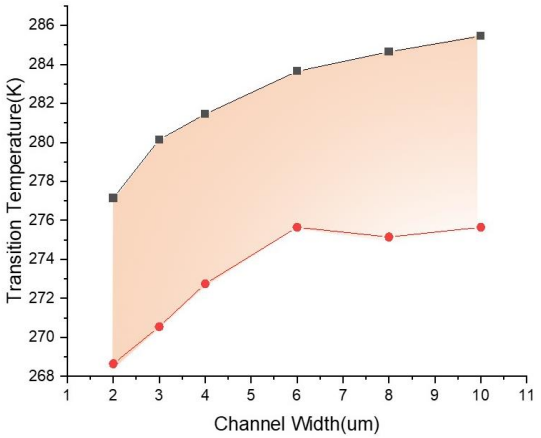

Fig.2 The estimated transition tempearures of the confined domains dependence on VO_2 channel width.

References:
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