PRIMARY DYNAMICS OF PHOTOINDUCED PHASE TRANSITION IN V_2O_3

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Photoinduced phase transition (PIPT) in strongly correlated material has attracted much attentions for more than 20 years. It enables us to expect ultrafast switching of optical and electromagnetic properties in the time scale of femtosecond to picosecond. Photoinduced Mott insulator to metal (I-M) transition is a typical example of PIPT for the future application to the ultrafast optical/electric switch operating in THz-PHz. One central issue to clarify is the mechanism of the PIPT from a Mott insulator to a metal. In this study, we investigated ultrafast dynamics of photoinduced I-M transition in the textbook Mott insulator V2O3 [1, 2] by transient reflectivity measurement using 6 fs nearly single-cycle infrared pulse. On the basis of the time resolved reflectivity spectra in the time scale of several tens femtosecond, we discussed the role of the electron-phonon interaction which governs the I-M transition in V_2O_3.

Pristine V_2O_3 is a metal at room temperature. With reducing temperature, paramagnetic metal (PI) to antiferromagnetic insulator (AFI), transition occurs at 175 K with the structural change from monoclinic to corundum. Thus, the PM-AFI transition strongly couples to the characteristic lattice structure V-V dimer (face shared octahedron dimer).

Figure 1 (a) shows the steady state reflectivity spectra at 120 K (AFI) and at 300 K (PM) [3]. Figure 1 (b) shows the spectral difference between them : $[R(300K) - R(100K)]/R(100K)$, reflecting the occurrence of the I-M transition. Figure 1(c) shows the transient reflectivity (ΔR/R) spectra at several time delays, after the excitation by 6 fs pulse (1.3 mJ/cm^2). After 200 fs, the spectral shape of ΔR/R is analogous to that of temperature difference shown in Figure 1(b), indicating that the I-M transition is completed within 200 fs. On the other hand, ΔR/R shows a different shape at 10 fs, i.e., a remarkable increase of the reflectivity for < 0.65 eV and a decrease for > 0.75 eV which are respectively attributable to the excited state absorption from the Franck-Condon state (< 0.65 eV) and the bleaching (> 0.75 eV). Figure 2 shows the time evolution of ΔR/R measured at 0.60 eV. In the time profile, we can notice the oscillation with a period of 128 fs (260 cm-1). This coherent oscillation is attributed to the V-V stretching motion. Therefore, we can conclude that the I-M transition is driven by the V-V motion from the Franck-Condon electronic state within 200 fs.

In my presentation, I will discuss about the electron-lattice dynamics of the photoinduced I-M transition in V2O3 in the time scale of several tens of femtosecond, and clarify how the primary motion of the Vanadium atoms begins.

Keywords Ultrafast Spectroscopy, PhotoInduced Phase Transitions, Carrier Dynamics

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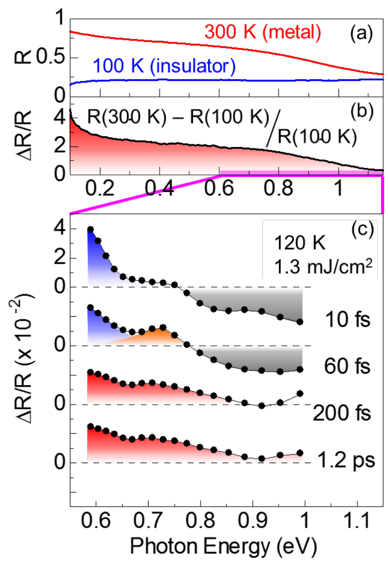

Figure 1: Temporal evolution of reflectivity changes ΔR/R.

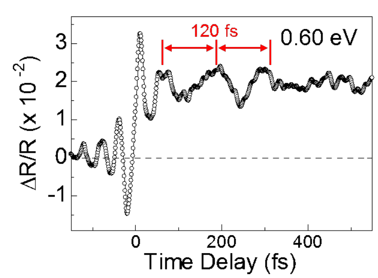

Figure 2: Temporal evolution of reflectivity changes ΔR/R.

References

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