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Photoemission study of TiO_2/VO_2 interfaces

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Introduction

Metal-insulator transition has been extensively studied because of its fundamental interest as well as its close relationship to remarkable phenomena such as high-temperature superconductivity in cuprates and colossal magnetoresistance in manganites [1]. Recently, high quality interfaces between transition metal oxides have became available due to the development of sample preparation technique. Particularly, interfaces between the band insulator $SrTiO_3$ (d^0) and the Mott insulator $LaSrTiO_3$ (d^1) have attracted interest because of its metallic behavior [2-5]. In the present work, we have performed photoemission spectroscopy (PES) measurements of interfaces between another d^0 band insulator TiO_2 and d^1 Mott insulator VO_2.

Experiment

VO_2/TiO_2 thin films were prepared using pulse laser deposition (PLD) technique. V_2O_3 pellet was used as a target. During the deposition, the substrate temperature was kept at 733 K and oxygen pressure was maintained at 1.0 Pa. The film thickness was about 10 nm-15 nm. TiO_2 capped samples were prepared as follows. The Rutile-type TiO_2 (r-TiO_2) deposited 673 K on the VO_2 thin film, while amorphous TiO_2 (a-TiO_2) was deposited TiO_2 at room temperature. Photoemission measurements were performed at BL-2C of Photon Factory. PES spectra were measured using a Scienta SES-100 analyzer.

Results and Discussion

PES spectra in the V 3d band region of VO_2, a-TiO_2/VO_2, r-TiO_2/VO_2 are shown in Fig. 1. All the spectra showed both coherent and incoherent parts. Incoherent part was observed most strongly in the r-TiO_2/VO_2 .This may be caused by the difference in the sample preparation process. In the r-TiO_2/VO_2 sample, Ti and V atoms may be interdiffused at the interface and the interface region may behave like Ti-doped VO_2 which become insulating as the Ti concentration increases. The temperature dependence of the V 3d band of a-TiO_2/VO_2, r-TiO_2/VO_2 are shown in Fig. 2. In both samples, metallic states were not observed in the interface between insulating VO_2 and insulating TiO_2 at low temperature, in contrast to the case of $SrTiO_3$-$LaTiO_3$ interface.

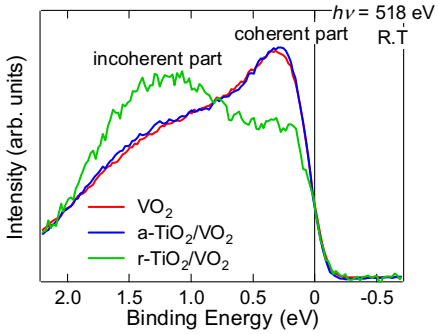

Fig. 1: V 3*d* band of VO_2, a-TiO_2/VO_2, r-TiO_2/VO_2.

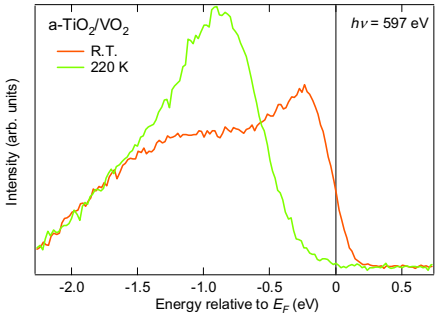

Fig. 2: Temperature-dependent photoemission spectra a-TiO_2/VO_2.

References

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