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Angle-resolved photoemission study of electronic structure of the TiO thin film formed on a TiC (100) surface.

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Introduction

TiC is known to have useful chemical and physical properties such as extreme hardness, a high melting point and metallic conductivity. In our recent study, it was revealed that the ordered TiO thin film was formed on the TiC (100) surface when the surface was oxidized at 1000°C [1]. The work function of the TiC (100) surface is lowered by the formation of the TiO thin film, and thus the electronic structure of the surface covered by the TiO thin film is of much interest. We report here the results of the angle-resolved photoemission spectroscopy (ARPES) study on the electronic structure of the TiO thin film.

Experimental

The ARPES measurements ware performed using synchrotron radiation at the beam line BL-11C.

As the TiC (100) surface is exposed to 1000L O_2 at room temperature, the C atoms are depleted due to the desorption as CO or CO_2 and the Ti atoms react with oxygen to form a disordered TiO_x ($1.5 < x < 2.0$) layer. This surface is reduced to the TiO thin film by annealing at 1000°C. The thickness of the TiO thin film is estimated to be 1 or 2 atomic layer [1].

Results and discussion

The normal-emission spectra of the TiO thin film are taken at various photon energies ($20.0\text{eV} < h\nu < 28.0\text{eV}$). The O 2p-derived band at about 6eV has no dispersion as a function of photon energy. This result suggests that this peak is derived from O atoms localized at the surface.

Fig.1 shows a two-dimensional band map of the TiO/TiC(100) surface. In Fig.1 the spectral weight of each peak in the second derivative of each off-normal-emission spectrum is plotted as a gray scale. Clear dispersion in the O 2p-derived band at around 6eV confirms that the O atoms in the TiO layer form a periodic structure with the (1×1) periodicity. The O2p-derived states are also formed near E_F. Fig.1 shows that the states show clear dispersions with the (1×1) periodicity. This result suggests that this states dose not arise from oxygen defects. These bands near E_F assigned as the Ti3d-derived states, which is predicted to exist in a TiO crystal around E_F by a theoretical study [2].

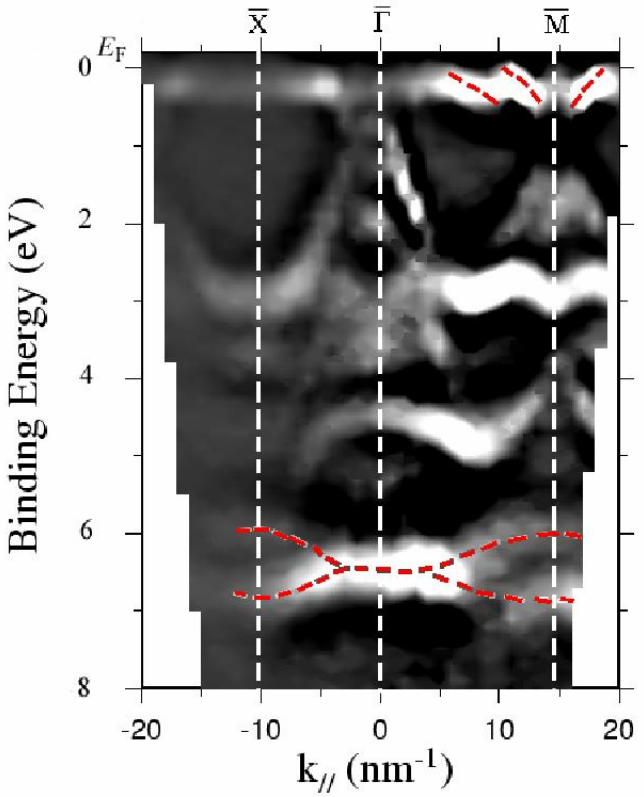

Fig.1 Experimental band structure of the TiO thin film. White zones represent peak position in ARPES. Dashed lines show TiO-derived bands.

References

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