

Thickness-dependent electronic structure of Dy silicide films grown on a Si(111) surface

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Introduction

The growth of rare-earth (RE) silicides on Si substrates have been subject of both technological and fundamental interest due to the possibility of device applications and the observation of various physical phenomena [1]. Of the RE silicides grown on a Si(111) surface, dysprosium (Dy) silicide has been reported to show a (1x1) structure, which consists of an ordered hexagonal monolayer of Dy that is located underneath a buckled surface Si layer, at a Dy coverage of 1 ML, and a ($\sqrt{3}\times\sqrt{3}$) reconstruction for thicker layer films [2]. The ($\sqrt{3}\times\sqrt{3}$) structure is formed by a defected AIB₂-type that consists of a surface with buckled Si hexagons, and stacked hexagonal Dy planes and graphite-like Si planes with every sixth Si atom missing [3]. Compared to the knowledge on their atomic structure, little is known on the thickness-dependent electronic structure.

Experimental

The photoemission measurements were performed at beam line 18A. In order to obtain a clean surface, we annealed the sample at 1230 K by direct resistive heating in the vacuum chamber to remove the oxide layer, and at 1520 K to remove carbon contamination from the surface. After the annealing, a sharp (7x7) LEED pattern was observed, and neither the valence-band spectra nor the core-level spectra showed any indication of contamination. The silicide films were grown by depositing Dy on a clean Si(111) surface at a substrate temperature of 800 K. The ARPES spectra were recorded at every 1° from $\theta_e=0^\circ$ to 65° in the [-110] direction, and from $\theta_e=0^\circ$ to 40° in the [11-2] direction.

Results and Discussion

The formations of a 1 ML (1x1) Dy silicide film and a 10 ML ($\sqrt{3}\times\sqrt{3}$) film were confirmed by LEED. Figure 1 displays the band dispersions of the two Dy silicide films. In Fig. 1(a), two prominent bands are observed in a binding energy range of 0 - 1.8 eV. Of these two bands, one corresponds to a nearly filled band crossing the Fermi level near the Γ point, and the other corresponds to a nearly empty band located around the M point. Both bands follow a (1x1) periodicity. Regarding the 10 ML film (Fig. 1(b)), the electronic structure is more complicate. The number of surface bands, which show a ($\sqrt{3}\times\sqrt{3}$) periodicity, becomes larger. This means that

these bands originate from the $\sqrt{3}$ periodic potential of the complicate surface structure.

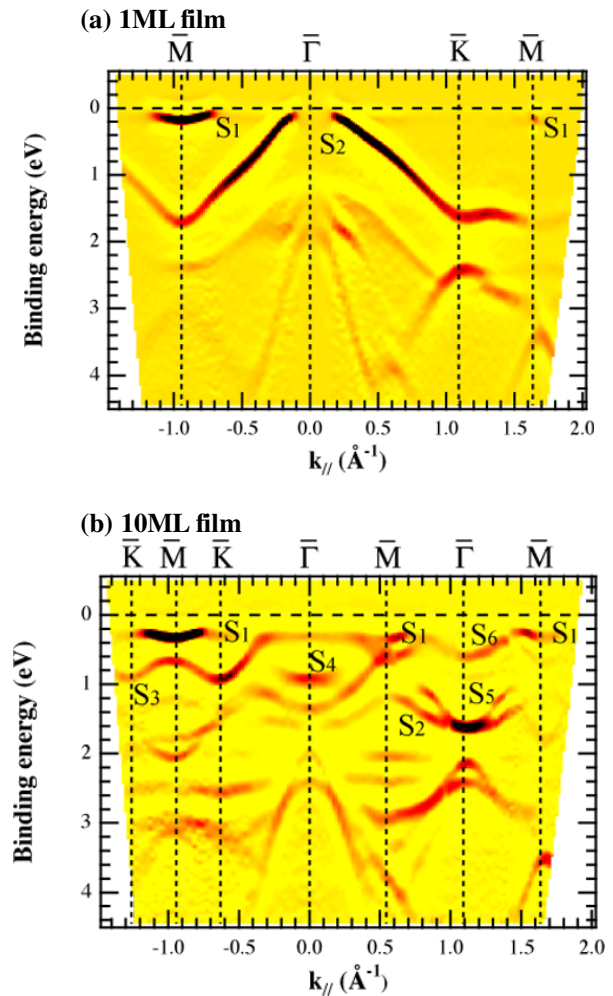


Figure 1: Band dispersion of the Dy silicide films. (a) a (1x1) 1ML Dy silicide film, (b) a ($\sqrt{3}\times\sqrt{3}$) 10ML Dy silicide film.

References

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