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Electronic Structure of Fe/W(100)

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1. Introduction

Electronic structure of Fe overlayers of thickness up to 4 ML, grown on W(100) substrate at room temperature(island growth) and 400K(layer-by-layer), has been studied using angle resolved photoemission spectroscopy(ARUPS). This system has drawn a lot of attention due to the question on the thickness of thermal equilibrium at 900K, where the magnetic property is expected to change quite abruptly. We confirmed the thermally stable layer thickness and their electronic structure of Fe/W(100) system in regards to its magnetic properties.

2. Experimental

We measured the angle-resolved photoemission spectroscopy of Fe on W(001) surface at room temperature using He-I discharge UV source(21.2eV) and a movable electron energy analyzer. A nearly perfect W(100) surface has been produced by repeated cycles of flashing after the prolonged annealing at 1800K in a 5×10^{-6} torr oxygen atmosphere and a flash in UHV to 2500K.

3. Results and Discussion

A series of representative arups data are displayed in Fig.1 and 2 with two-dimensional (2D) wave vectors $k_{/\!/}$ along the M (left side) and X (right side) for Fe/W (100) as a function of Fe coverage (1ML and 4ML) at 298K. In Fig. 1 a normal emission spectrum at $k_{/\!/} = 0$ Å^{-1} is located in the bottom of each box, while top spectrum has $k_{/\!/} = 1.406$ Å^{-1}, close to the zone boundary M (left side) and $k_{/\!/} = 0.993$ Å^{-1}, close to the zone boundary X(right). As shown in fig.1 and 2, tungsten bulk state shows up dominantly regardless of Fe coverage up to 4ML. This is the obvious evidence that Fe forms an island on W (100) at room temperature.

To confirm the difference in growth mode as a function of substrate temperature, which change the mobility of surface atom, we focus on the electronic structure along Γ-M. Fig.3 presents a series of representative arups data with two-dimensional (2D) wave vectors $k_{/\!/}$ along Γ-M for Fe/W(100) as a function of substrate temperature (Left: at 298K and Right: at 400K) for 3ML. As shown in fig.3, we can see the clear different spectra between both spectra. The ARP spectra grown at 400K (right side) do not appear the tungsten bulk state peak and band dispersion show different behavior. Fig.4 depicts the annealing effect of Fe/W(100) at a coverage of 2ML where not much variation is shown. As a result, in Fe/W(100) system, 2ML is thermally stable coverage.

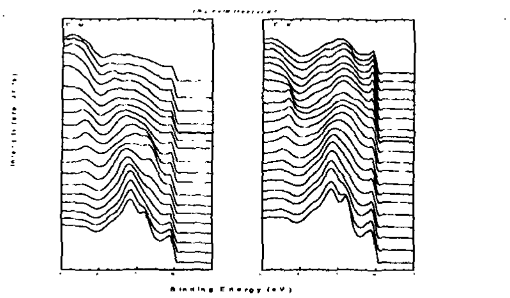

Fig.1. ARP spectra (2D) wave vectors $k_{//}$ along Γ-M and Γ-X for 1ML Fe/W(100) at RT (Left: Γ-M and Right: Γ-X)

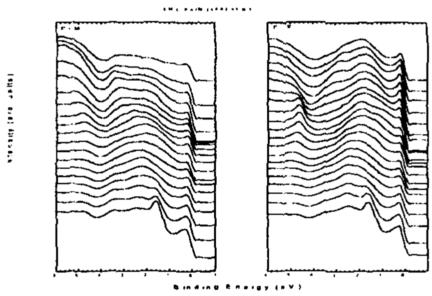

Fig.2 ARP spectra (2D) wave vectors $k_{//}$ along Γ-M and Γ-X for 1ML Fe/W(100) at RT (Left: Γ-M and Right: Γ-X)

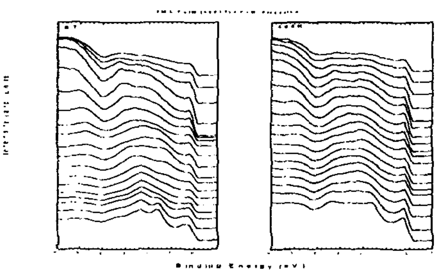

Fig.3. ARP spectra (2D) wave vectors $k_{//}$ along Γ-M for Fe/W(100) as a function of substrate temp. (Left: at 298K and Right: at 400K) for 3ML.

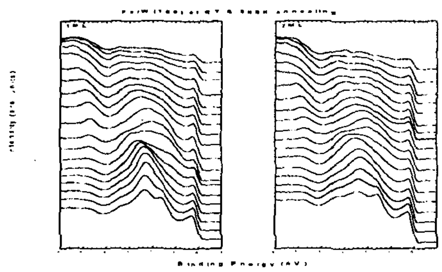

Fig.4 ARP spectra wave vectors $k_{//}$ along Γ-M for Fe/W(100) at RT and 900K annealing (Left: 1 ML and Right: 2ML)

4. Conclusion

The thickness where Fe forms an uniform layers at 900K on W(100) surface is 2ML. Although we have not present the results of band mapping here in digest from, it clearly shows the change in its electronic structure from antiferromagnetic to ferromagnetic ordering vs. the film thickness. All of these spectra will be interpreted based on the FLAPW calculation reported previously.

5.Reference

[1] W. Wulfhekel, F. Zavaliche, F. Porrati, H. P. Oepen and J. Kirschner, Europhys. Lett, **49**, 5 (2000)