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Electron correlation effects in Co nano-islands on a nitrogen covered Cu(001) surface

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Recently, the atomic and electronic structures of magnetic nano-structure on surfaces have been intensively studied. We have investigated the initial growth of Co nano-islands on a nitrogen saturated Cu(001) c(2×2)-N surface by scanning tunneling microscopy (STM) and x-ray photoelectron spectroscopy and found that the nitrogen segregates on top of the Co islands[1]. The morphology of the surface is shown in Fig. 1. In the present study, we discuss the electronic structure of this system in terms of electron correlation effect investigated by x-ray absorption spectroscopy (XAS) at both Co L- and N K-edges comparing with the growth process studied by STM. The experiments were performed using linearly polarized incident light in both NI (normal incidence) and GI (grazing incidence) geometries to examine the polarization dependence. All the data were obtained at room temperature.

N K-edge absorption spectrum shows the increase of the absorption intensity just above the Fermi level with the increase of Co coverage. This indicates that the bonding of N 2p with Cu 3d changed into that with Co 3d which has smaller number of 3d electrons than Cu. The result strongly supports the segregation of N atoms to form N/Co layer on top of the Co nano-islands.

In the Co L-edge spectrum, a shoulder structure was found only in NI geometry at an energy 3 eV higher than the main peak both at L_3 and L_2 edges as shown in Fig. 2. Its intensity gradually decreases with Co coverage below 2ML on average. To discuss the origin of the 3 eV shoulder, we have optimized the stable atomic structure of the single- and double-layer N/Co films by the first-principles method and calculated the Co 3d density of states. Also, we have simulated the spectra considering the multiple scattering effect using FEFF code. The experimental results, however, were not reproduced[2]. The multiplet splitting was also excluded comparing to the multiplet calculation in d^8 configuration[2]. Therefore, the origin of the 3 eV shoulder is considered to be the correlation satellite. Comparing with the STM observation, the satellite is attributed to the perimeter atoms in N/Co layer of the single- and double-layer islands. Such perimeter atoms have low coordination number and narrow 3d band width, which would enhance the electron correlation. The polarization dependence of the satellite would be attributed to the anisotropy of the correlation due to N-Co hybridization at the perimeter.

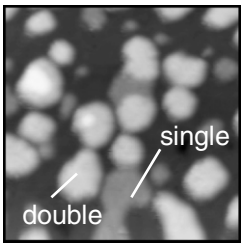

Fig. 1 STM image of Co nano-islands on a nitrigen-saturated Cu(001) surface. The average Co coverage is 0.8 ML. Single- and double-atomic height Co islands with N atoms on top of them are indicated.

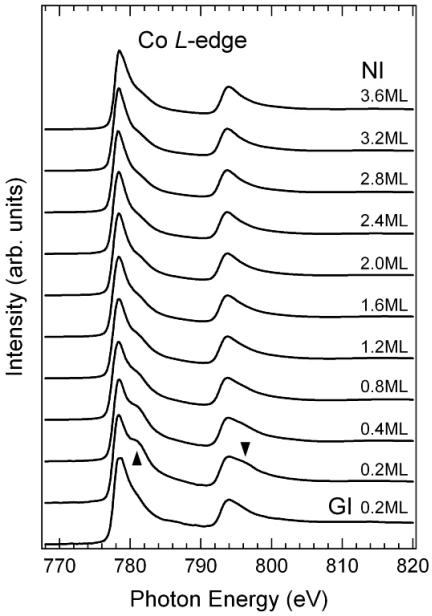

Fig. 2 Coverage dependence of Co L-edge absorption spectra in NI geometry. The 3 eV shoulder is indicated by the arrows in the case of 0.2 ML of Co. A spectrum in GI geometry is also shown.

References

[1] D. Sekiba et al., Surf. Sci. 590, 138 (2005).
[2] K. Nakatsuji et al., Phys. Rev. B, accepted.

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