The Electronic Structure of Ultrathin NiO Films on Ag(100) Surfaces

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The investigation of the electronic structure of transition metal oxides thin film on metal substrates have been a topic of great interest. Especially NiO thin film provides the chance to a larger number of applications, such as magnetic nanodevices technology. The geometric structure, electronic properties, and reactivity of oxide films a few atomic layers thick deposited on metal surfaces are expected to be different from those of the surfaces of bulk oxides due to the nanometric thickness of the films and the interaction with the substrate. The study of relatively simple oxides such as NiO grown on metal surfaces is relevant in order to understand fundamental aspects concerning the structure and properties of ultrathin oxide films on metal surfaces.

Well-order NiO film was grown by evaporating Ni in an oxygen atmosphere on Ag(100). The Ag(100) surface appears to be an ideal substrate for NiO films due to the small lattice mismatch and the scare reactivity of silver towards O_2. The thickness of NiO thin film was determined by quartz thickness monitor and RHEED. The low-energy electron diffraction shows a two-domain (2x1) pattern for the 0.9 monolayer (ML) NiO thin film at O_2 pressure in the $5x10^{-7}$~$8x10^{-7}$ Torr range at 180 ℃ annealed. The (2x1) pattern evolves to a (1x1) pattern upon further annealing to 350 ℃ in the presence of O_2 or upon increasing film thickness. The angle-integrated photoemission spectra normalized by constant photon flux helium discharged lamp shows a finite density of states at Fermi level for 0.9 ML (2x1) NiO/Ag(100) and 2 ML (1x1) NiO/Ag(100). It means a metallic behavior for both structure.

Angle-resolved photoemission spectroscopy was used to detect the band dispersion of the 0.9 ML (2x1) NiO and 2 ML (1x1) NiO thin films on Ag(100), as well as of a 10 ML film. The band dispersion of the 10 ML thick film was similar to that of the bulk crystals. Weak dispersion of valence bands was observed on the (2x1) NiO thin film, which was very different from that on the (1x1) for 0.9 ML and 2 ML NiO thin films. A tight-binding model may be used to resolved the reason.

1. C. Giovanardi, A. di Bona, and S. Valeri, *Phys. Rev. B* **69**, 075418 (2004).
2. D. A. Hite et. al., *J. Vac. Sci. Technol. A* **18(4)**, 1950 (2000)
3. Z.-X. Shen et. al., *Phys. Rev. B* **44**, 3604 (1991).

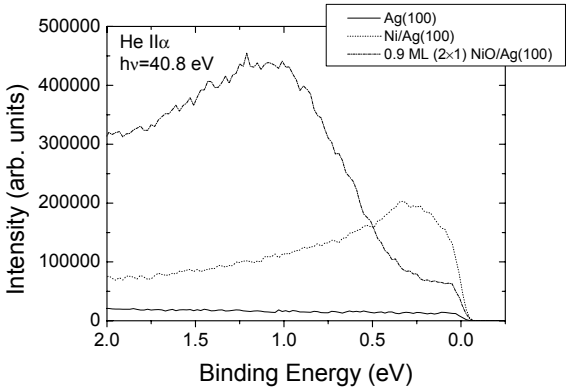

Figure (a). The photoemission spectra and (b) that near Fermi level of the clean Ag(100), Ni/Ag(100) and 0.9 ML (2×1) NiO/Ag(100), all taken at 40K with He II_α

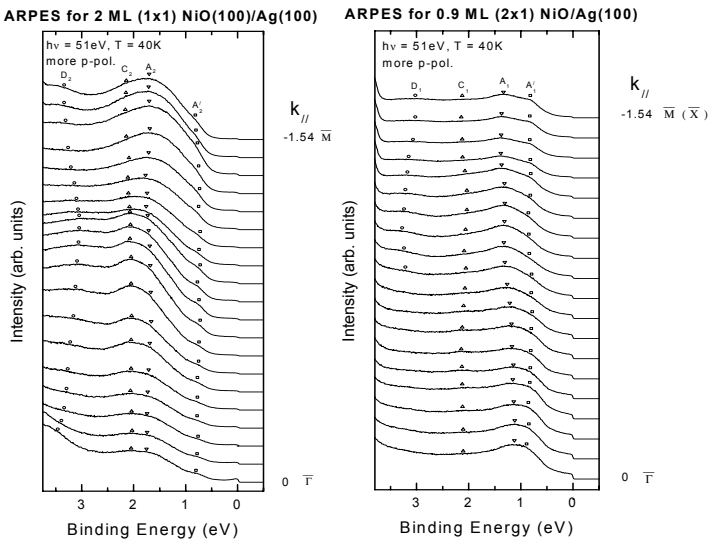

Figure (b). Angle-resolved photoemission data for 2 ML (1x1) NiO/Ag(100) and 0.9 ML (2×1) NiO/ Ag(100)