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Metal induced gap states at LiCl/Ag(001) interface studied by x-ray absorption fine structure

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Introduction

While there are mounting interests in the nature of the "heterointerface" (solid-solid interfaces between very dissimilar materials), insulator/metal interfaces are especially intriguing, since they provide fascinating possibilities such as metal-insulator transition, band gap narrowing and superconductivity as well as technological ones such as catalysis, magnetic tunneling junctions, etc. Despite these interests, electronic structures characteristic of the insulator/metal interface have not been studied satisfactorily. In the present study, we have prepared the well-defined alkali halide/metal interface [1]. Near edge x-ray absorption fine structure (NEXAFS) was used to study electronic structure characteristic of insulator/metal interface.

Experiment

Epitaxial LiCl films were grown on Ag(001) at 300 K by evaporating LiCl from a Knudsen cell. The growth rate was on the order of 1 ML (2.6Å). The Cl-K edge NEXAFS measurements were carried out at the soft X-ray double-crystal monochromator station BL-11B in the Photon Factory in the National Laboratory for High Energy Physics. The Cl-K NEXAFS provides information on the unoccupied Cl-p states.

Results and Discussion

Figure 1 shows the Cl-K edge NEXAFS spectra for LiCl/Ag(001) taken at grazing X-ray incidence for various thicknesses of the LiCl layer. All the spectra are normalized by their edge-jump. As the thickness of the LiCl layer is decreased, a pronounced pre-peak (P) emerges below the bulk edge onset. The appearance of the pre-peak indicates that new states are formed at the LiCl/metal interface.

XPS and AES results supported that the pre-peak originates not from chemical bonds at the LiCl/metal interface, the states formed by the proximity to a metal. The gap states can be qualitatively understood as MIGS.

We have estimated the decay length of the MIGS into the insulating side from the dependence of the intensity of the pre-peak on the thickness of the insulating layer. By fitting the experimental data with the theoretical curve, the decay length was determined to 2.9 ±0.7 Å, which indicated that the MIGS were indeed localized within a few Å of the interface.

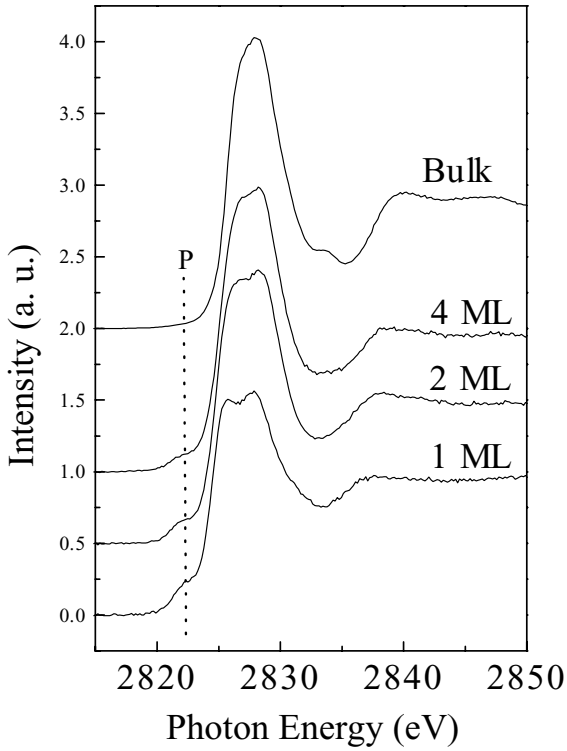

Fig.1: Thickness depedence of the Cl K-edge NEXAFS for the LiCl film grown on Ag(001).

References

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