Hard X-ray Photoemission Spectroscopy of Ca_2RuO_4 under electric field

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It has been fundamental and challenging issue in condensed matter physics to understand strongly correlated electronic states in the vicinity of the Mott insulating phase. Recently, the correlated electronic states under electric field are receiving growing interest. Recent experiment on a Mott insulator Ca_2RuO_4 has demonstrated an intriguing electric-field induced insulator to metal transition with a nonlinear conductivity [1]. The threshold electric field E_{th} of ~40 V/cm for Ca_2RuO_4 is weakest among the Mott insulators. Even more surprisingly, a record-giant diamagnetism under electric current has been reported [2]. Thus, it would be desirable to understand how the applied low electric field changes the Mott insulating state and causes the giant diamagnetism.

Here, we performed hard x-ray photoemission spectroscopy measurements on Ca_2RuO_4 under electric field to reveal the current-induced evolution of the electronic states. By using high energy photons of the hard x-ray, one can minimize the influence of the applied electric field on the locus of photoelectrons. From the spectra near the Fermi level, we found that the size of insulating gap decreases with applied electric field. The present observation supports the gap suppression scenario for the non-linear conductivity proposed in a previous study [3]. Furthermore, the spectral weight of the lower Hubbard band is suppressed with increasing the current. These results are consistent with the elongation of compressed RuO_6 octahedra by current and give constraints on the mechanism of the giant diamagnetism.

References

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