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Improving the accuracy of spin detection using lock-in techniques

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Spin-resolved photoemission spectroscopy is an experimental technique that can measure not only the binding energy and momentum of electrons in a material but also spin information (spin-polarization and spin-orientation). To obtain spin information Very Low Energy Electron Diffraction (VLEED) spin detector is utilized at HiSOR, in which spin-polarization is observed by measuring the intensity asymmetry between the reflected electrons by the positively and negatively magnetized target[1].
However, spin detection is generally inefficient and the spin-resolved photoemission measurement is time-consuming, which presents challenges such as (1) detecting small spin polarization and (2) sample degradation over time, affecting measurement reliability.

To overcome this problem, in this study, we tried to develop a lock-in detection system in spin detection to improve the measurement accuracy of spin-resolved photoemission. In order to utilize the lock-in technique into the VLEED spin detection the continuous modulation of some signals relating to the spin-polarization is needed. To this end, we tried to use the two different working points (i.e. two different electron injection energies to the target) where the intensity asymmetry by spin-dependent electron reflection in VLEED becomes positive and negative at the each working point instead of changing the magnetization of target positively and negatively as in the conventional VLEED spin detection[1]. We sought the condition where the intensity asymmetry of reflected electrons between the two working points matches that between the positively and negatively magnetized targets.

Figure 1(a) and (b) show the results of the spin-polarization measurement of Bi(110) Rashba state at some specific *k*-point taken with the conventional VLEED spin detection measurement by electron reflection intensities from the positively and negatively magnetized target as well as by electron reflection intensities at two different working points. As seen in the figures, it was clarified that almost the same results were obtained by both methods. Thus, we have confirmed that the periodic signal modulation necessary for the lock-in technique can be obtained by the periodic change of the working points in VLEED spin detection. We plan to perform actual lock-in measurements in near future.

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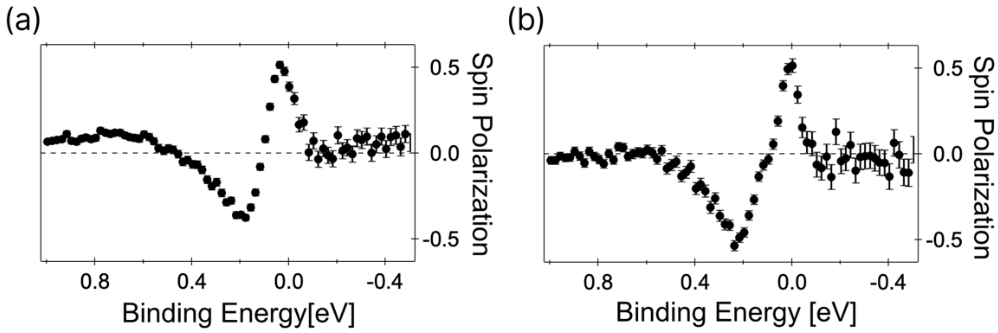

FIGURE 1. (a)Spin polarization of Bi(110) at the specific k-point measured by conventional method using magnetization reversal of target. (b) the same as (a) but by the new method using the two different working energy points (two different electron injection energies).

REFERENCES

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