

反射高速陽電子回折の実験

Experiments of Reflection High-Energy Electron Diffraction (RHEPD)

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Reflection high-energy positron diffraction (RHEPD) is a strong tool to determine the structure of the first surface layer of crystals. Since the positron has a positive charge, the total reflection takes place at grazing incidences [1]. Taking advantage of the total reflection, one can obtain the information about atomic configurations and thermal vibrational states of the first surface layer. In order to verify the usefulness for surface structure analyses, we developed the RHEPD apparatus using a ²²Na source [2,3].

In 2010, a new RHEPD apparatus based on the linear accelerator (LINAC) was constructed at the Slow Positron Facility at the Institute of Materials Structure Science, KEK [4]. We succeeded in obtaining the RHEPD patterns and rocking curves [5]. The diffracted intensity was 14 times as large as the previous ²²Na source method. In 2012, to enhance the brightness of incident positron beams, the remoderator composed of 100-nm-thick W foil was developed and installed in front of the RHEPD chamber. The highly monochromatic and parallel positron beam was generated by using the remoderator. The beam flux of the positron beam was increased to $\sim 10^5$ e⁺/sec. The energy spread at the positron energy of 10 keV is dramatically reduced from 110 eV to 8 eV. The beam radius was estimated to be 1.0 mm (FWHM).

As a result, we succeeded in observing clearer RHEPD patterns from the Si(111)-7×7 surface, as shown in Fig. 1. The fractional-order spots in the high-order Laue zones are clearly observable, which have been never seen in the pattern using the ²²Na source. The measurements of RHEPD rocking curves were also successful. The intensity was 44 times as large as the ²²Na source method.

In order to observe much clearer patterns, a magnetic lens system will be installed into the RHEPD chamber. The RHEPD method with intense and bright positron beams will be applied to further advanced surface

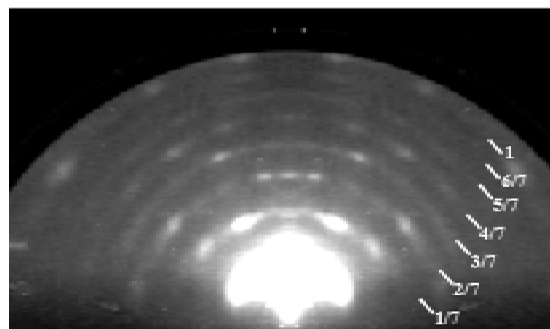


Fig. 1 RHEPD pattern of the Si(111)-7×7 surface measured by using the LINAC-based RHEPD apparatus. The incident azimuth of the positron beam corresponds to the $[11\bar{2}]$ direction. The glancing angle is set at 2.2°. The index on the right-hand side indicates the Laue zone. The pattern shows the superimposition of the left and right parts.

systems such as low-dimensional surface and Rashba surface. Furthermore, a direct method to determine atomic positions will be developed on the basis of the Patterson analysis.

References

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