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実験室特性Ｘ線源を用いた高速逆格子空間マッピング法の開発

Quick reciprocal space mapping with a laboratory characteristic X-ray source

KEK-PF[1]，東京学芸大[2]，東大物性研[3]

○フォグリ　ヴォルフガング[1]，松下正[1]，荒川悦雄[2]，白澤徹郎[3]，高橋敏男[3]

Photon Factory, KEK[1], Dept. of Physics, Tokyo Gakugei Univ.[2], ISSP, Univ. of Tokyo[3]

○Wolfgang Voegeli[1], Tadashi Matsushita[1], Etsuo Arakawa[2], Tetsuroh Shirasawa[3], Toshio Takahashi[3]

E-mail: wolfgang.voegeli@kek.jp

In X-ray reciprocal space mapping, the two- or three-dimensional distribution of the scattered X-ray intensity around a specific reciprocal space position, for example a Bragg peak, is recorded. The intensity distribution gives information about the epitaxy, domain structure and layer thicknesses of thin films and multilayers.

The conventional method for measuring reciprocal space maps is to record the intensity with a point detector, while scanning detector and sample angles. A quicker method is to use an area detector and record the intensity for a specific sample orientation. In this method, however, the range of reciprocal space that can be observed simultaneously is limited by the range where the Ewald sphere cuts the region of interest in reciprocal space (for example the shaded region around C_L in Fig. 1).

Recently, a method for measuring reciprocal space maps covering a wide range in reciprocal space was developed [1]. This method uses a convergent X-ray beam from a synchrotron source with a range of X-ray energies. In this poster, we present a similar method suitable for monochromatic X-rays from a laboratory source. This method should make it possible to do time-resolved or high-throughput measurements using standard laboratory sources. The method can also be modified to use monochromatic synchrotron radiation.

The principle of the method is illustrated in Fig. 1. A slit inclined from the horizontal selects a diagonal line from the divergent X-ray beam emitted from a point source. This beam is focused with a doubly curved silicon crystal monochromator (Johan type) onto the sample. For each horizontal direction, the beam has a different incident angle ω onto the sample. The reflected beam is observed with a 2D pixel array detector (Pilatus 100K) placed after the sample. The image on the detector can be transformed to give the reciprocal space map in the Q_x-Q_z plane.

[1] T. Matsushita *et al*., J. Appl. Phys. 110, 102209 (2011)

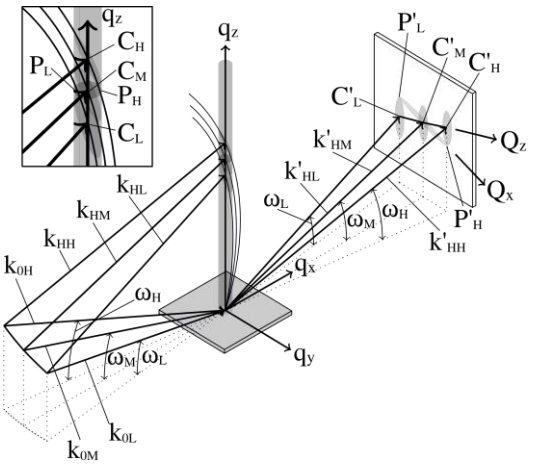

Fig. 1 Principle of the quick X-ray reciprocal space mapping method in real and reciprocal space. A fan shaped convergent X-ray beam k_{0L}-k_{0H} is incident onto the sample with a range of angles ω_L-ω_H. In reciprocal space, the reflected beams k_{HL}-k_{HH} cut a crystal truncation rod around the positions C_L-C_H. By recording the reflected beams $k`_{HL}$- $k`_{HH}$, the reciprocal space in the range C_L-C_H can be observed at once.