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Sub-Second Time Resolution Reciprocal Space Mapping for Observation of III-V Semiconductor Thin-Film Growth

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In-situ reciprocal space mapping during thin-film growth provides important information for understanding growth processes, like lattice relaxation and the generation of defects [1]. It is a challenge, however, to achieve time resolutions below the seconds range. In this contribution, we present a high-speed reciprocal space mapping method that can be used for in-situ observations of non-repeatable phenomena with a time resolution 100 ms and less, and its application to the growth of III-V semi-conductor thin films.
Experiments were conducted at the undulator beamline 11XU of SPring-8, where a surface X-ray diffractometer combined with a molecular beam epitaxy chamber is installed. An X-ray optical system was set up in the experimental hutch to transform the collimated and monochromatized synchrotron radiation beam entering the hutch into a convergent X-ray beam with a wide range of incident angles onto the sample. By observing the intensity distribution of the X-rays diffracted at the sample with a two-dimensional detector, the scattering distribution in a wide range of momentum transfer can be observed simultaneously with a single detector exposure.
The setup was used to observe the growth of InGaAs on GaAs(001) and of InGaN on GaN. The initial stages of the growth as well as the relaxation of the films when the thickness increased were observed with a time resolution of 100 ms.
In addition to high-speed reciprocal space mapping at monochromatic 3rd generation synchrotron beamlines, the method might also be useful for simultaneous observation of an extended region of reciprocal space using a single pulse from an XFEL source.
[1] M. Takahasi, Jpn. J. Appl. Phys. 57 (2018) 050101.

I plan to submit also conference proceedings

Yes

Primary authors: VOEGELI, Wolfgang (Tokyo Gakugei University); TAKAHASI, Masamitu (QST); Prof. SASAKI, Takuo (QST); Dr FUJIKAWA, Seiji (QST); Mr SUGITANI, Kanya (University of Hyogo); SHIRASAWA, Tetsuroh (NMIJ, National Institute of Advanced Industrial Science and Technology); ARAKAWA, Etsuo (Tokyo Gakugei University); Prof. YAMAGUCHI, Tomohiro (Kogakuin University)

Presenter: VOEGELI, Wolfgang (Tokyo Gakugei University)

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