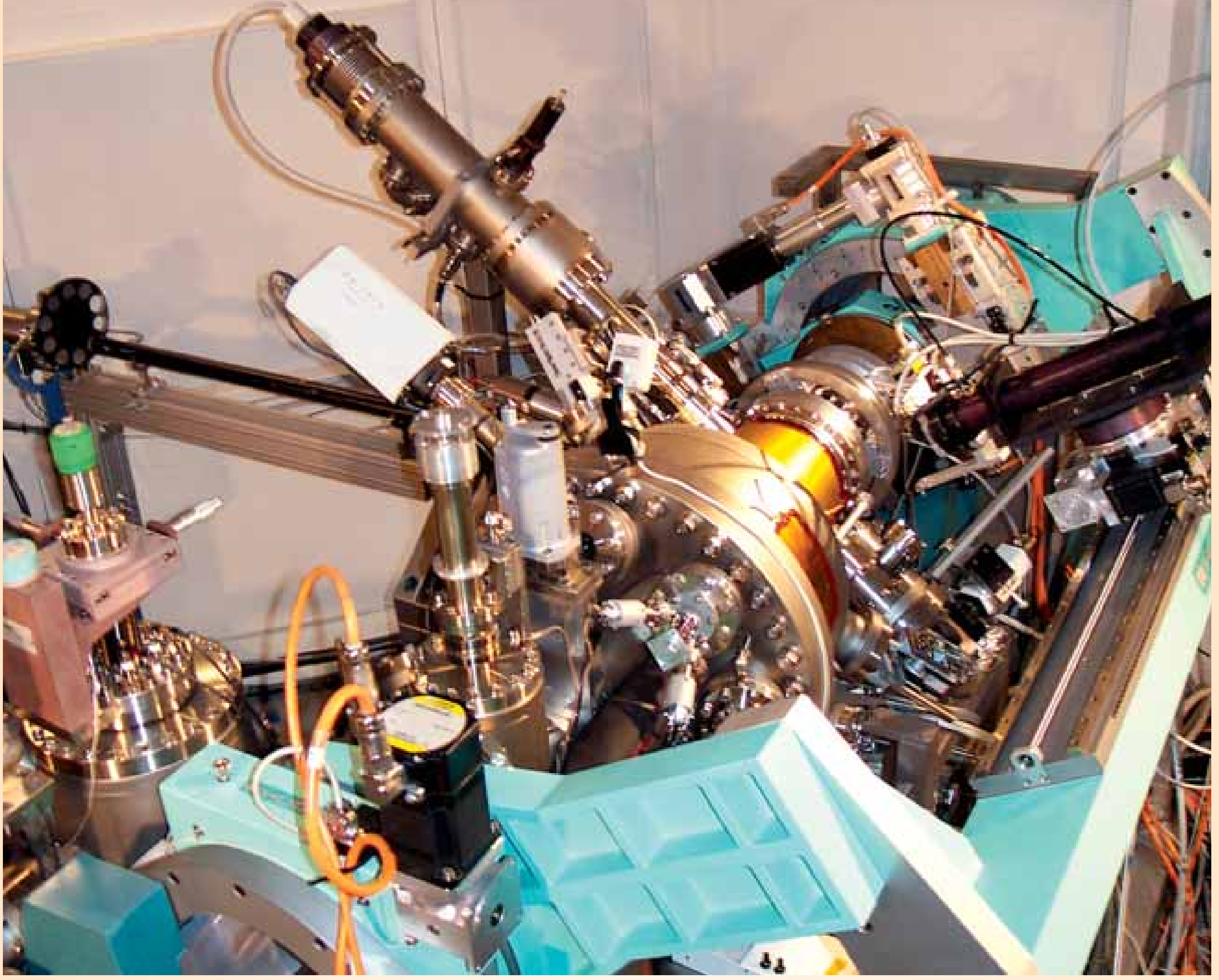


MBD AND X-RAY DIFFRACTION

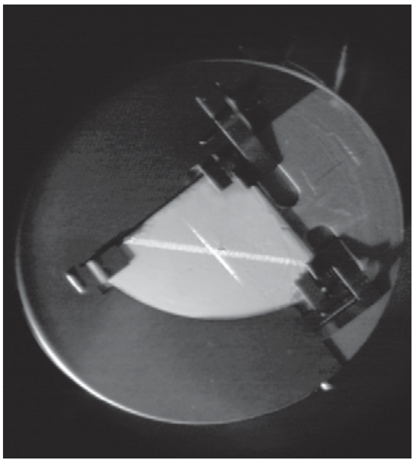
Equipment for in situ real-time synchroton radiation studies during MBD

Designed and manufactured by CreaTec Fischer & Co. GmbH

CREATEC

COMPETENCE IN MBD

MBD AND X-RAY DIFFRACTION



The x-ray beam (horizontal) and RHEED beam (diagonal) simultaneously visualized using a fluorescent dummy sample.
Both beams are precisely aligned to the center of the diffractometer and allow combined RHEED/X-ray studies.

The PHARAO Experiment

The PHARAO Project of the Paul-Drude Institute (PDI) at BESSY II in Berlin is dedicated to the in situ real-time characterization of MBD growth using synchrotron x-ray diffraction.
In collaboration with a diffractometer manufacturer and the scientific team at the PDI, CreaTec designed and built the mission-critical MBD experiment which is now successfully operating at a dedicated beamline.
The system has exceeded all specifications. In addition CreaTec has manufactured two new systems for material systems, metals and oxides.

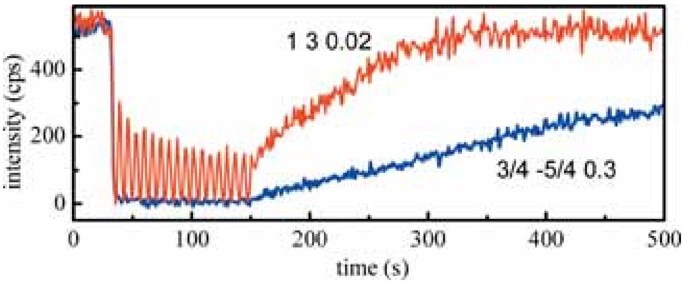
A Versatile System

Despite the restriction of being incorporated into a highly precise six-circle diffractometer, the MBD system needs to provide MBD growth conditions similar to stationary research systems.
Large Be windows allow incidence and exit polar angles of 0° to 45°, and exit azimuthal angles of 0° to 110°.
The chamber features three liquid nitrogen cooled shrouds, ports for 7 effusion cells and a permanent video sample surveillance for alignment.
The chamber is pumped by turbo, ion and Ti sublimation pumps and has a base pressure in the upper $10E^{-11}$ mbar range with arsenide growth.
The sample holders rigidly couple to the sample stage, which is directly connected to the innermost circle of the diffractometer.
Sample movements are transferred into vacuum by torque-compensated bellows and a two-stage differentially pumped rotation feedthrough.
Sample temperatures up to 1000° are possible.

The high-precision RHEED system HP-4/Safire can be operated simultaneously with x-ray diffraction. During operation, the complete system inside the radiation safety hutch is remotely controlled by our Emeralt software. For sample introduction, a three chamber transfer system is integrated into the diffractometer platform.

Results

The first measurement campaign has focused on surface x-ray diffraction studies of GaAs growth kinetics.
With the x-ray intensities available at BESSY II, layer-by-layer growth can be studied with a time resolution down to 1 s.
On reconstructed surfaces, the terrace or island kinetics can be separated from the reconstruction kinetics by choosing appropriate diffraction conditions.
The data indicate qualitatively different coarsening kinetics of islands and reconstruction domains at typical GaAs growth conditions.



Layer-by-layer growth and recovery of GaAs (001) on an integer order rod (island kinetics) and a fractional order rod (reconstruction domains). Sample temperature is 560 °C.

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