EpiRAS®: Monitoring in AIX 200 and AIX 200/4

This document describes an additional feature of the EpiRAS® sensor: using the oscillations of the Reflectance Anisotropy Spectroscopy (RAS) signal it is possible to monitor the rotation speed of the satellites in AIX 200 and other gas-foil driven growth reactors in-situ before and during the growth.

At Ferdinand-Braun-Institut in Berlin, an EpiRAS® 2000 TT system was used to measure the rotation speed of the wafers / satellites in situ during the growth. The experiments were performed in an AIX 200/4 MOCVD reactor in a 3x2" configuration. In this type of growth system, the wafer plates are floating on a gas foil of carrier gas and are rotated by the flow of the gas. By changing the gas flow, the rotation frequency can be adjusted. Because different growth temperatures, pressures, total flow and weight of the satellites changes the rotation frequency at constant rotation gas flow, a verification of the rotation or a measurement of the rotation speed is highly desirable. The used liner quartz tube with a frosted top makes an effective control of satellite rotation difficult. Using the RAS signal it is now possible to check whether the satellites are rotating or not and even to measure the actual rotation speed.

Reflectance Anisotropy Spectroscopy (RAS), also know as Reflectance Difference Spectroscopy (RDS), measures the anisotropic optical response of surface reconstructions, of interface bonds and of doping induced internal electric fields by taking the difference in the reflectance for light polarised along two axes x and y of the crystal under investigation. The normalized reflectance signal is calculated as follows:

$$\frac{\Delta R}{R} = 2\frac{R_x - R_y}{R_x + R_y}$$

Surface dimers with a certain orientation are responsible for the difference in the amplitude of the RAS signal:

Benefits:

- Analysis of RAS signal oscillations gives wafer rotation
- Demonstrated for AIX 200 and other gas-foil driven reactors
- Direct analysis allows real-time process monitoring and control

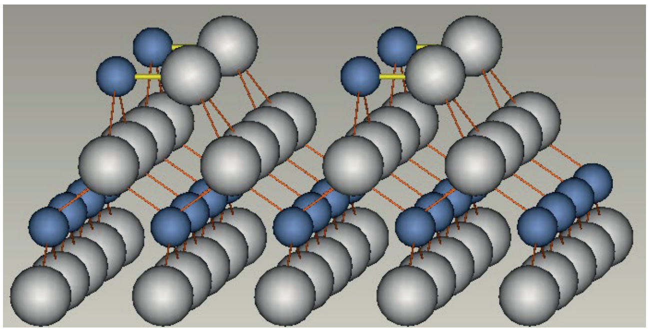


Fig. 1:
InP (001) - (2x4) reconstruction / mixed In-P dimers (side view)

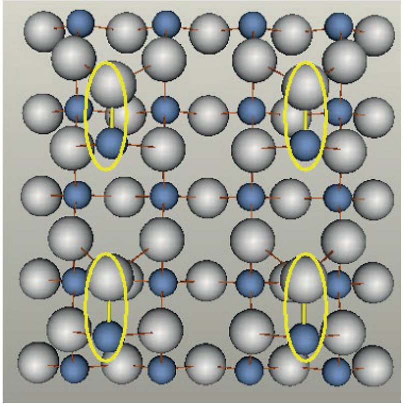


Fig. 2: Fig. 2: Top view In-P dimers

Rotation of the wafer and thereby of the orientation of the dimers under the linear polarized light causes an oscillation of the RAS signal. So, there is a direct relation between the oscillation of the RAS signal and the rotation of the wafers during growth, whereby one full rotation of the wafer results in two full oscillation periods of the RAS signal (Fig 3).

In a multiple wafer (Planetary Reactor®) configuration these RAS signal oscillations during growth (Fig. 4) demonstrate directly whether all satellites are rotating homogeneously. In the measurements shown below, rotation of satellite #2 of the three satellites was blocked for demonstration (Fig. 4). The measurement allows the operator to adjust the rotation by changing the rotation gas flow.

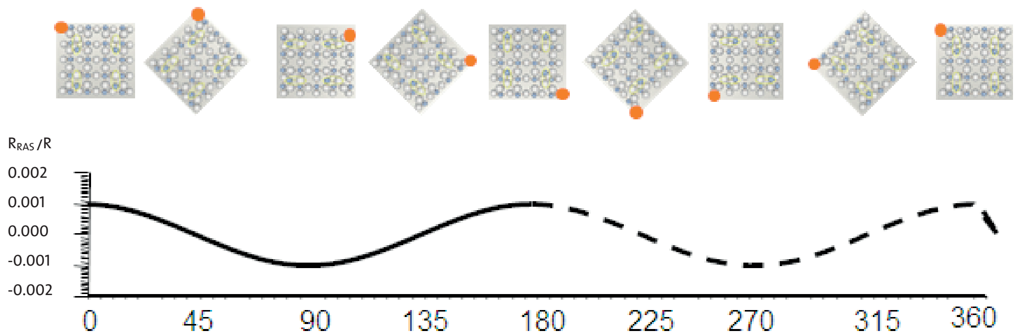
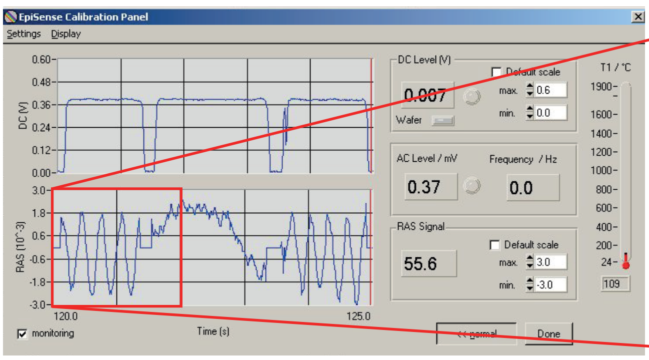


Fig. 3: Rotation angle of wafer in degree



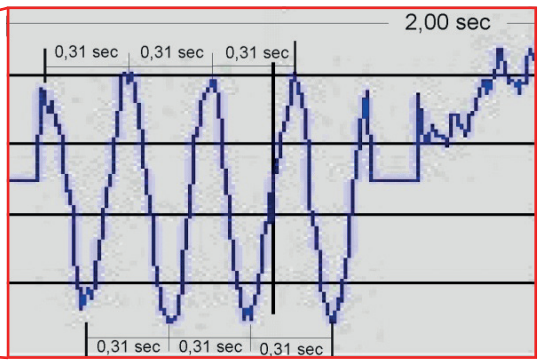


Fig. 4: Screenshot of the EpiSense calibration panel. In the upper window: reflectance signal during one full susceptor rotation; all three wafers are recognizable. In the lower window: related RAS signal. The oscillations of the signal as an indication for the rotation of satellites #1 and #3 is well visible. On satellite #2 no oscillation is visible: this satellite is blocked for demonstration.

Fig. 5: Zoom of the RAS signal of wafer #1. The peak to peak time measurements gave all the same time difference of 0.31 seconds. So, a full satellite rotation takes 0.62 seconds or 97 rpm.

www.laytec.de/epiras

Version 03-2019

LayTec AG
Seesener Str. 10-13
10709 Berlin, Germany

Tel.: +49 (0)30 89 00 55-0
Email: info@laytec.de
Web: laytec.de

Knowledge is key