XRD Measurement and Evaluation of complex e-Mode and d-Mode Heterostructures

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X-ray diffraction is one of the basic analytical methods that are routinely utilized for both materials research and quality control processing. It is non-destructive and offers high precision and accuracy in lattice distance and orientation measurements.

The method subset of reciprocal space mapping has the advantage of separating features in two dimensions that allow judgement of material functionality and quality being otherwise convoluted in a rocking curve. For complex buffer structures this has profound advantages for the metrology of layers between GaN and Silicon substrates.

We demonstrated in recent years a technique called ultrafast reciprocal space mapping (URSM) that made these measurements feasible in a timescale required by industrial QC. With the release of our new Advanced Material Analysis and Simulation Software (AMASS) we enabled the automation of the RSM analysis for GaN heterostructures as necessary second step. Next to the buffer layer, also the AlGaN barrier can be analysed in an improved way with URSM compared to rocking curves (Fig. 2). New is the automation of so called "In-plane" measurement to directly assess the twist and a-lattice parameter close to the surface (Fig. 1). While most people treat the GaN as pseudosubstrate when calculating the AlGaN composition of their barrier, Figure A shows the GaN a-lattice parameter not being constant over the wafer radius. The difference between center and edge is 570 ppm and corresponds to about 10% of the mismatch of an average d-mode HEMT AlGaN barrier. We will give an overview about the possibilities to link data acquisition and analysis into lab environments controlled by SECS/GEM or scripts.

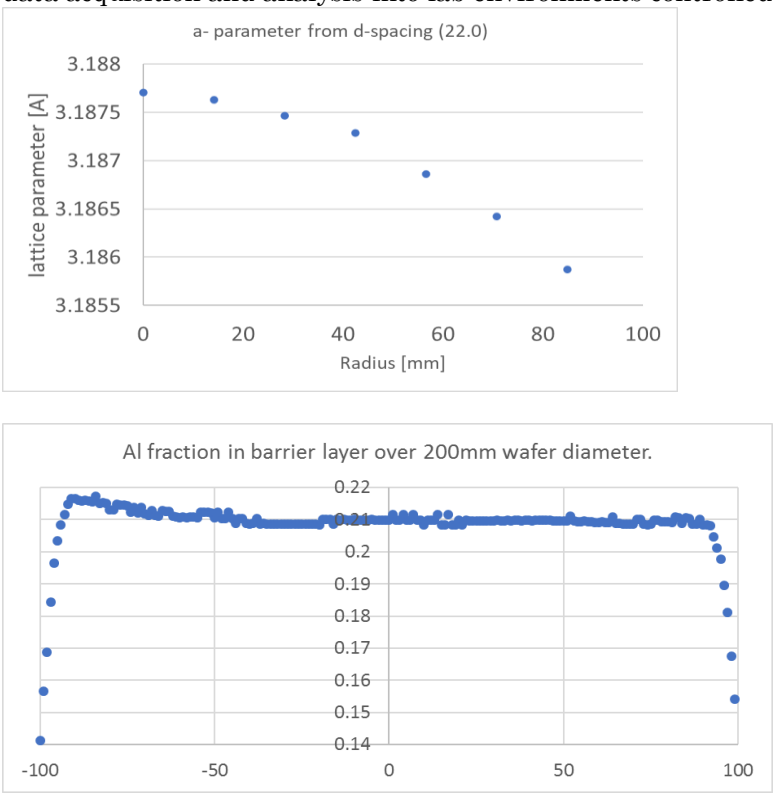

Figure 1 Edge to edge result plot of 200 URSM in automatic evaluation

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Determining Crystal Offcut in less than 10 seconds

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The classic orientation method via rocking curves at different azimuthal angles is a widely spread method that yields results in 10-30 minutes for near vicinal crystals. Here we present a fast method that can orient both boules for sawing and check the wafer offcut and flat orientation as QC tool for both manufacturer and client. Offcut magnitude precision is evaluated to 0.003° 1σ and automation options range from manual to fully fab compliant to cover the needs of both research and industry with benchtop to workfloor sized installations.

This is a breakthrough in methods compared to current industrial standards and would enable control of each individual wafer at a throughput of more than 2.5 million wafers per tool per annum.