



## X-RAY DIFFRACTION IMAGING QC-TT

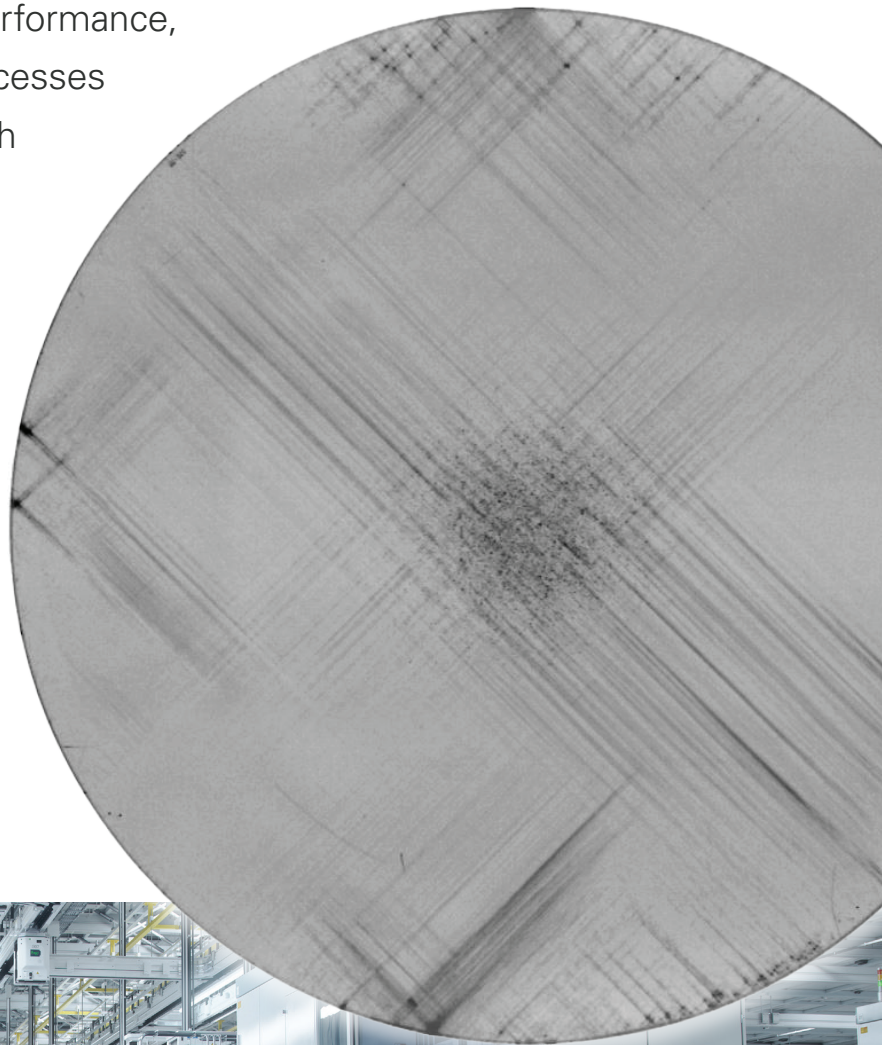
Production-Dedicated Solution for Non-Visual Defect  
Detection and Classification in High-Value Substrates

# QC-TT Non-Visual Defect Detection

Non-visual defects (NVD) cannot be identified by optical inspection, yet they have a significant impact on the reliability of wafers and devices. Bruker's QC-TT, the most advanced transmission X-ray diffraction imaging topography tool, allows detection of defects previously unseen by any other production-scale techniques on both blanket and patterned wafers. This ultimate quality control solution can be used to predict performance, ensure reliability, and improve processes all the way from materials research to production deployment. Fully automated detection of critical defects can be conducted before polishing on high-value wafers, leading to fast feedback early in the manufacturing process.

## Only QC-TT delivers:

- Non-destructive full-wafer imaging at industry-leading high throughput.
- Rapid and accurate detection of non-visual crystalline defects.
- Full automation from wafer loading, defect detection, and defect classification to results reporting.



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# X-ray Diffraction Imaging Capabilities

## XRDI Methodology

X-ray defect inspection utilizes the long-established and powerful X-ray diffraction imaging (XRDI, also known as X-ray topography) to generate digital whole-wafer images, where defects causing strain or tilt in the crystal lattice create diffraction contrast in the final image. Automated analysis, defect detection, and defect classification allow a comprehensive review of potential killer defects.

## Transmission XRDI Benefits

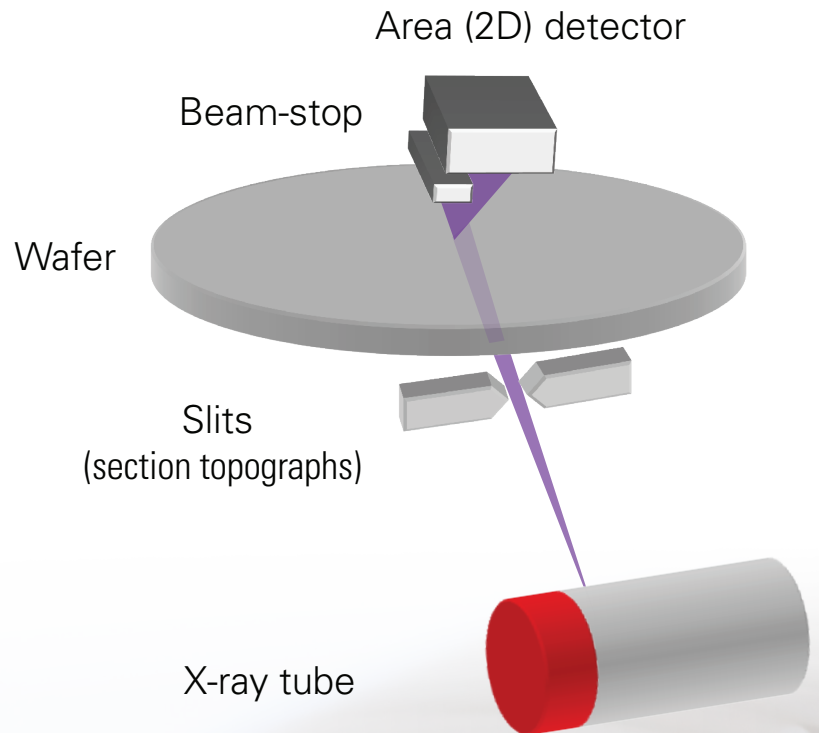
XRDI is inherently non-destructive, has a wide material compatibility, and requires no sample preparation. In transmission XRDI, the source is below the sample and the detector is above, enabling through-imaging for simultaneous detection of surface and bulk defects. Through-imaging with zero edge exclusion ensures that all defects are accounted for (including those at notches and bevels) and that no killer defects pass undetected in the bulk of the substrate or at non-flat edges.

## Detectable Defects

- Dislocations
- Slip
- Cracks and micro-cracks
- Surface scratches
- Micropipes
- Precipitates
- Sub-grains

## The Bruker Advantage

Bruker has been innovating in the XRDI field for decades. QC-TT is optimized for use in high-throughput production environment lines, with full automation of wafer loading, measurement, image processing, defect analysis, and reporting. XRDI is valuable in R&D as well as process ramp and production environments for development, monitoring, and troubleshooting. Even after the QC-TT tool is installed, Bruker continues to help you, from training and application support to extended service.



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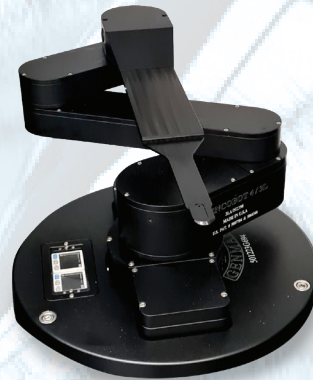
Tool configuration for transmission XRDI measurements.

# High-Throughput Production Monitoring

QC-TT is the state-of-the-art XRF system for Si production yield improvements. It features fully automated wafer loading, alignment, and measurement, as well as automatic defect detection, defect classification, and KLARF reporting. Being sensitive to all types of crystalline defects, from edge cracks to slip and dislocations, QC-TT is well-suited to failure analysis applications. No sample preparation is required, and the transmission geometry ensures that defects throughout the bulk material are captured.

## Automated Wafer Handling

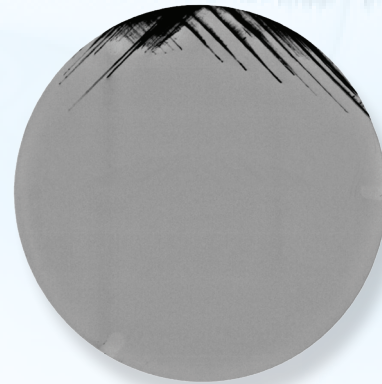
Manual handling and loading of wafers can be time-consuming and lead to handling errors of wafers. QC-TT offers automated robot loading to increase throughput, improve loading accuracy, ensure repeatability, and reduce required resources.



Automated wafer handling robot.

## Production Wafer Monitoring

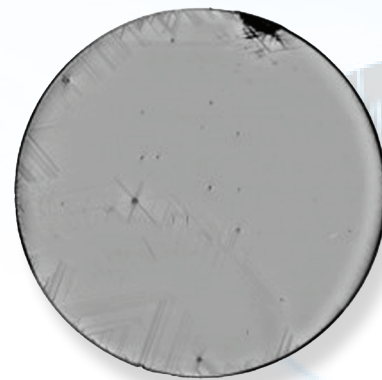
Finding the first good wafer from a boule can require multiple rounds of cutting and testing. QC-TT's high-speed survey can be used to optimize ingot slicing by quickly measuring the length of slip lines, which can be used to predict the location of the next defect-free wafer. This predictive process results in less time and resources being used on cutting and testing of wafers.



High-speed XRF survey image of Si boule wafer showing slip around wafer edge.

## Front-End Process Ramp

Parameter tuning can be slow when using low sampling rates or slow characterization techniques. QC-TT offers a high sampling rate with full-wafer survey imaging and is capable of full automation. Using this high-speed imaging with automated defect detection and classification results in a more informed and efficient process ramp.



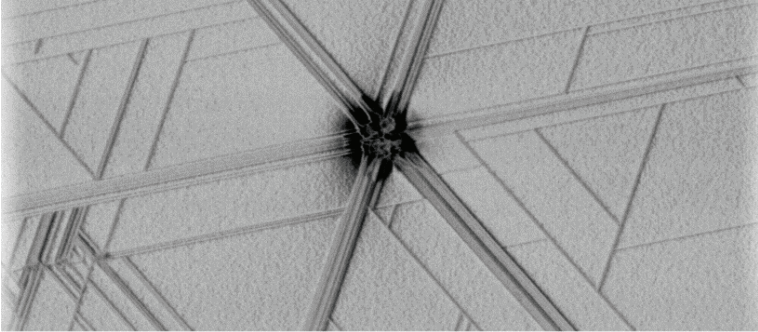
High-speed XRF survey image of Si wafer with GaN epilayer showing multiple micropipes, dislocations, and slip.

# High-Resolution and Cross-Section Review Analysis

In addition to high-speed full-wafer survey imaging, QC-TT also offers high-resolution and cross-section review modes to further investigate the nature and depth-location of individual defects, enabling rapid and accurate failure analysis and enhancing R&D processes.

## High-Resolution Review Mode

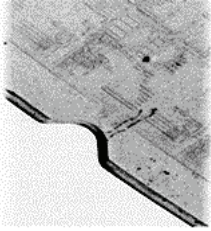
QC-TT includes a high-resolution camera, enabling additional detailed examination of individual defects. The KLARF file generated from the survey image can automatically direct the camera to collect a high-resolution image of a specific defect when required. Automated reports with pass/fail criteria can also be generated, which can immediately be used to improve the production process.



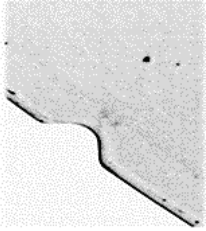
High-speed XRF high-resolution image of defect in Si wafer with GaN epilayer showing dislocations along crystallographic planes.

## Cross-Section Review Mode

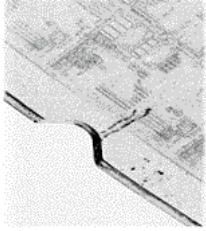
By closing the source slits near to the sample, the image across the diffraction stripe becomes a virtual wafer cross section and can be used to identify approximate depth location of defects. Collections of cross-section images can be automatically collected to form depth-sensitive slice images in selected areas of the wafer. This automated non-destructive technique provides greater detail for defect analysis throughout the manufacturing process.



Full-depth analysis.

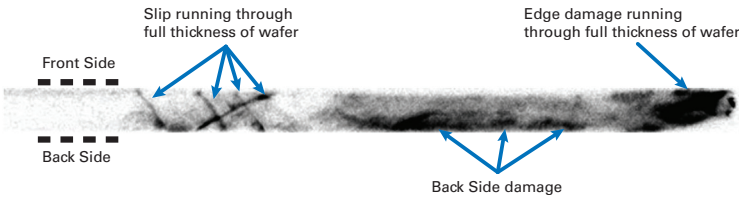
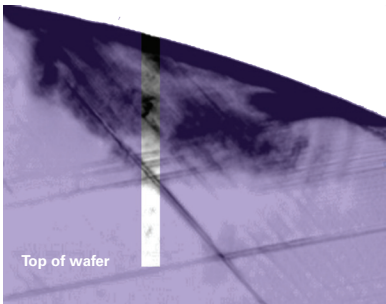


Back-side analysis.



Front-side analysis.

Top: XRF top view of wafer.  
Below: Cross-section image of highlighted region.



# Customizable Automation and Analysis

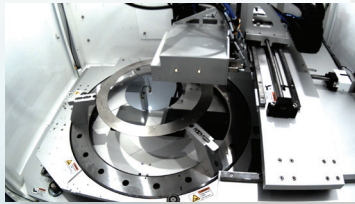
QC-TT features fully automated wafer loading, alignment, and measurement, eliminating the need for manual handling and increasing productivity.

## Wafer Load



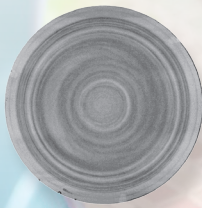
- Reliable wafer handling ensures precise and repeatable wafer positioning.
- Options are available for a range of common wafer sizes up to 300 mm, including non-round boule slices.
- Software automatically detects wafer cassette size and wafer shape.

## Align



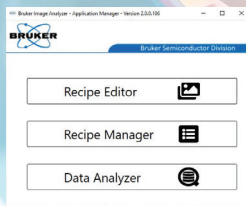
- Fast and precise alignment algorithms automatically align the wafer before measurement to ensure successful, accurate, and repeatable measurements.
- Detector resolution automatically switches between survey (high speed) and review (high resolution) modes.

## Measure



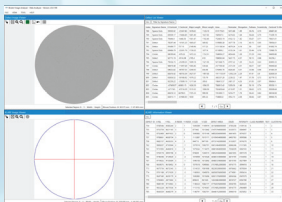
- Measurements are run by assigning customizable automated recipes.
- Multiple recipes can be assigned to different wafers at a variety of locations on the wafer.
- Survey, review, and cross-section modes can all be assigned in recipes.

## Analyze



- Automated in-recipe analysis utilizes Bruker's powerful defect detection software.
- Analysis is easily customizable to detect the defects that matter to you.
- Defects are automatically classified and counted.

## Report



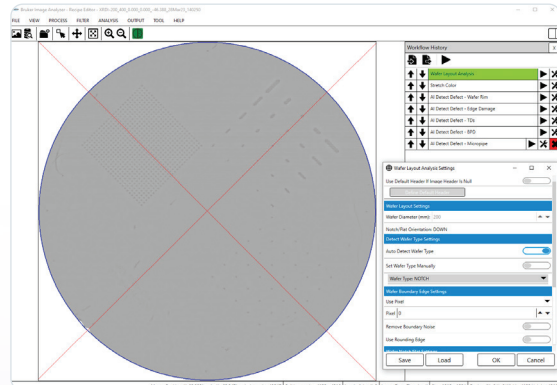
- KLARF reporting
- Wafer and defect images
- Detailed defect classification and summary lists
- Simple pass/fail reporting

# Defect Detection and Classification

Bruker Image Analyzer (BIA) defect detection and classification software offers fully automated data processing and reporting: tried and trusted in fabs around the world. BIA can classify defects based on one or more of over 30 object parameters, including shape, size, location, intensity, and orientation.

## Automatic Defect Detection Recipes

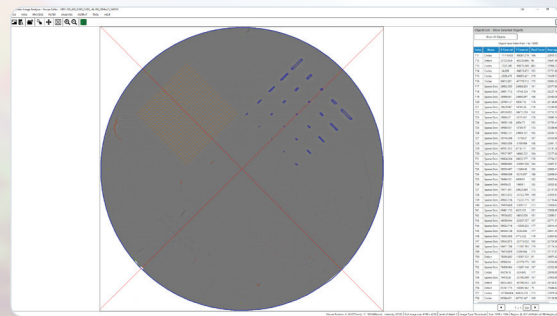
- Easily customizable recipes with BIA recipe editor
- Works with blanket and patterned wafers
- Recipe runs automatically after measurements
- Automated AI to detect range of defects
- Choose which defects to identify
- Run multiple recipes at the same time through BIA recipe manager



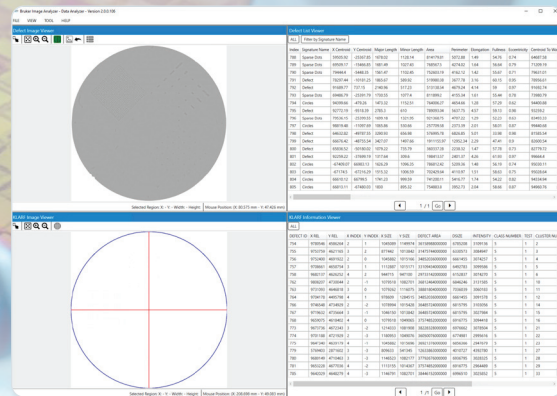
BIA Recipe Editor: recipe creation.

## Automatic Defect Detection Outputs

- Original XRF image
- Defect overlay images
- CSV files containing individual defect details
- Summary of results for each defect class
- KLARF image with optional die map grid overlay
- KLARF defect information
- PDF with pass/fail using customizable defect criteria



BIA Recipe Editor: defect overlay image with defect summary.



BIA Data Analyzer: defect image view with defect list and KLARF image viewer with KLARF information list in BIA.

# QC-TT Specifications

Each wafer manufacturing facility and semiconductor fab has its own specific requirements and challenges. Our listed product specifications and offerings are always a starting point for a conversation with our experts to determine how our capabilities can meet your needs.

Survey Mode Throughput (Wafer Dependent)	300 mm = 7 wph; 200 mm = 10 wph; 150 mm = 13 wph; 4 inch = 14 wph; 3 inch = 15 wph
X-ray Tube / Generator	3.0 kW Mo sealed tube; optional 2.0 kW Ag sealed tube for denser substrates
Camera Resolution	48 $\mu\text{m}$ (survey) and 11 $\mu\text{m}$ (review) pixel size cameras as standard
Wafer Size Compatibility	Small coupons and wafers up to 300 mm (manual loading); 2"–200 mm / 200 mm and 300 mm wafers and boule slices (automatic loading)
Optional Robot Loader	Robot loading of 100–200 mm or 200–300 mm samples; vacuum end effector; maximum payload 1 kg
Common Defect Types Detected	Crystallographic defects including slip, dislocations, cracks, scratches, micropipes, precipitates, sub-grains
Defect Detection / Analysis Software	Bruker Image Analyzer (BIA)
X/Y Stage	0.001 mm resolution; 200 mm or 300 mm range
Phi Stage	0.01° resolution; Unlimited range
Transmission Goniometer	0–30° omega range; <10" resolution

## Bruker's Industry-Best Service and Support

Bruker is a metrology solutions expert with a deep experience in semiconductor fabrication plants. We actively leverage our semiconductor fab experience to develop solutions that meet the evolving needs of high-volume production environments. We know that down-time and excursions are costly, so maximizing up-time is at the core of how our tools are designed and how our service and support operates.

Bruker has a long tradition of partnering with our customers to solve real-world application issues. After developing next-generation technologies with industry leaders and assisting customers in selecting the right system and accessories, this partnership continues through training and extended service long after the tools are sold. Our highly trained and certified team of support engineers, application scientists, and subject-matter experts are dedicated to maximizing your productivity.

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