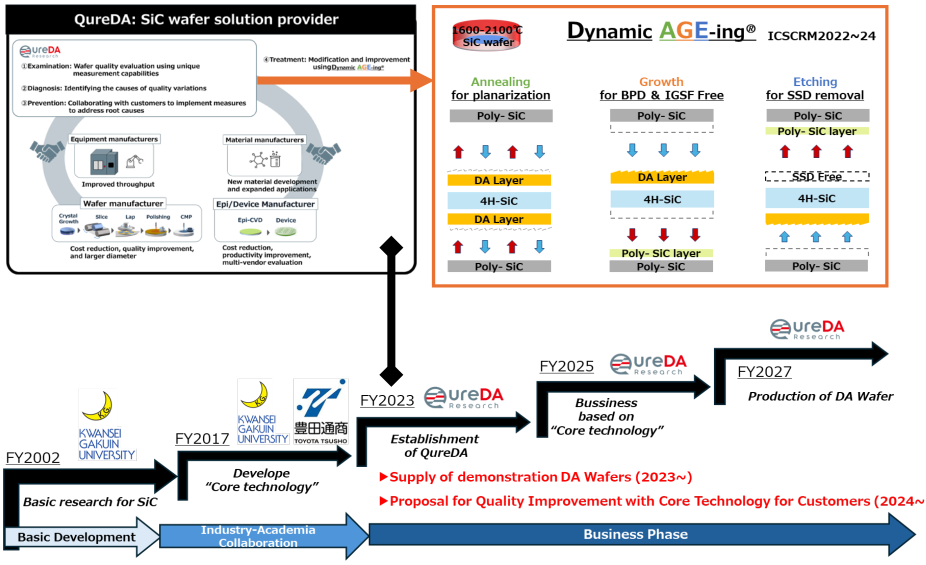
Function of QureDA Research

QureDA provides comprehensive solutions for SiC wafer manufacturers, device makers, material suppliers, and equipment manufacturers.Through four key functions — Examination, Diagnosis, Prevention, and Treatment — we help our partners achieve wafer quality improvement, throughput enhancement, large-diameter wafer development, and device reliability stabilization.In particular, the Dynamic AGE-ing® technology, which corresponds to the " treatment " function, fundamentally improves SiC wafer quality by controlling silicon and carbon atoms at high temperatures of 1600–2300 °C to heal crystal defects.This technology is based on over two decades of research conducted at Kwansei Gakuin University since 2002.In 2023, QureDA Research, Inc. was established as a joint venture between Kwansei Gakuin University and Toyota Tsusho Corporation, with development support from Toyota Motor Corporation.QureDA aims to achieve mass production and social implementation of Dynamic AGE-ing® technology by 2027.



Our Approach for SiC quality Issues

The quality of SiC wafers is mainly affected by crystal strain introduced during the crystal growth process and processing-induced strain generated during wafering. Solving these quality issues directly contributes to reducing quality variation for wafer manufacturers, and improving reliability and performance for device manufacturers.At QureDA, we realize SiC wafer quality improvement through a unique approach based on two core technologies: Dynamic AGE-ing (DA) and Laser Light Scattering (LLS).In the following slides, we will explain our specific roles by comparing our customers—wafer and device manufacturers—to patients.Using this analogy, we will introduce how our technologies serve as functions for Examination, Diagnosis, Prevention, and Cure.

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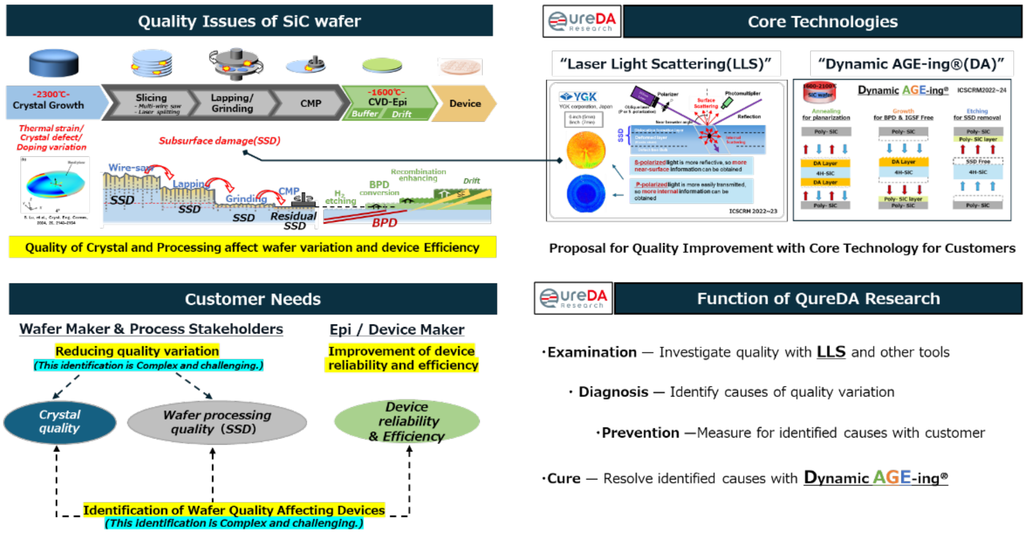


·**Examination** — Investigate quality with **LLS** and other tools

· **Diagnosis** — Identify causes of quality variation

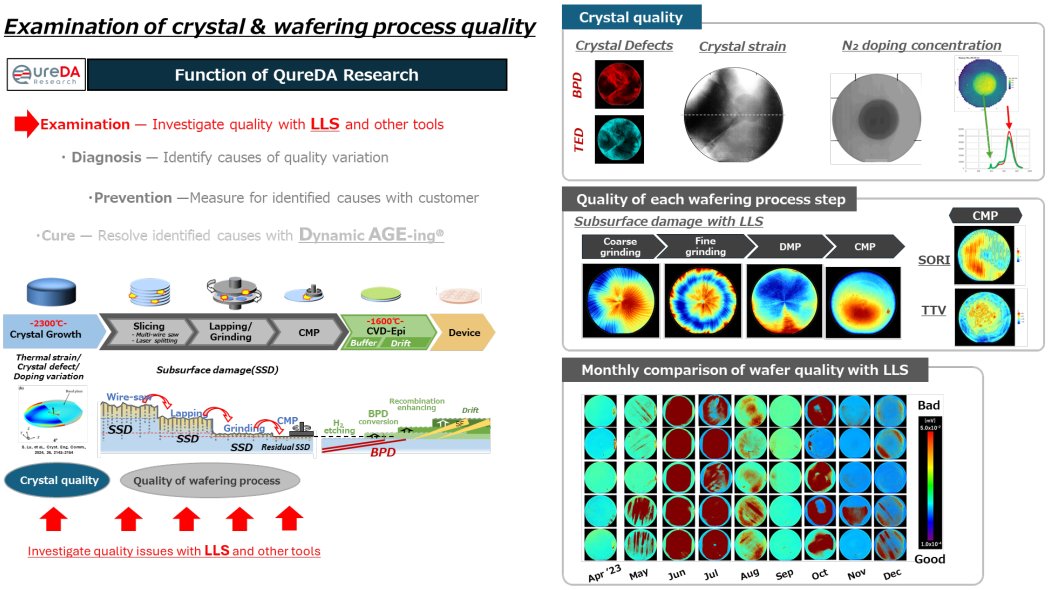
·**Prevention** —Measure for identified causes with customer

·**Cure** — Resolve identified causes with **Dynamic AGE-ing®**

Examination of crystal & wafering process quality

This slide introduces the first phase of our quality improvement process: Examination.

We assess both crystal and processing quality using Laser Light Scattering (LLS) and other evaluation tools.Crystal quality is evaluated from multiple perspectives, including defects, strain, and doping concentration variation.Processing-induced strain is assessed for each individual wafering process step, as well as monthly trends over time.These examination results form the basis for the next phases: Diagnosis, Prevention, and Cure.



Examination of crystal & wafering process quality

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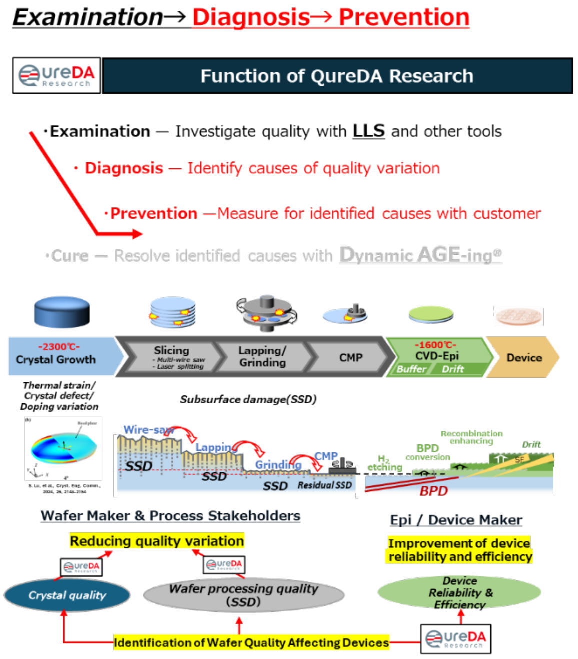
Investigate quality issues with **LLS** and other tools

Quality Stabilization through Examination and Diagnosis

Diagnosis is the step where we identify the root causes of quality variation based on Examination results and propose concrete improvement measures.For example, variations in nitrogen doping concentration and the presence of crystal defects during the crystal growth process affect wafer hardness, leading to non-uniform processing accuracy.Thermal strain can also cause wafer warpage, resulting in uneven contact with polishing pads.As crystal quality and processing quality are tightly interconnected, understanding their complex causal relationships is critical for improving overall wafer quality.In the figure on the right, we illustrate an actual case where wafers from different vendors were analyzed to identify crystal quality factors responsible for SSD (Subsurface Damage) using the LLS method.Through this approach, QureDA proposes customized countermeasures based on LLS evaluations tailored to each customer's specific quality challenges.Prevention refers to the process of supporting customers as they implement improvement activities derived from the diagnostic results, while continuously monitoring quality trends to achieve early stabilization.By regularly assessing both crystal and processing quality, we objectively determine whether the customer’s actions are moving in the right direction.This ongoing support enables customers to achieve tangible results, ultimately accelerating wafer quality stabilization and process optimization.



Examination→ Diagnosis→ Prevention

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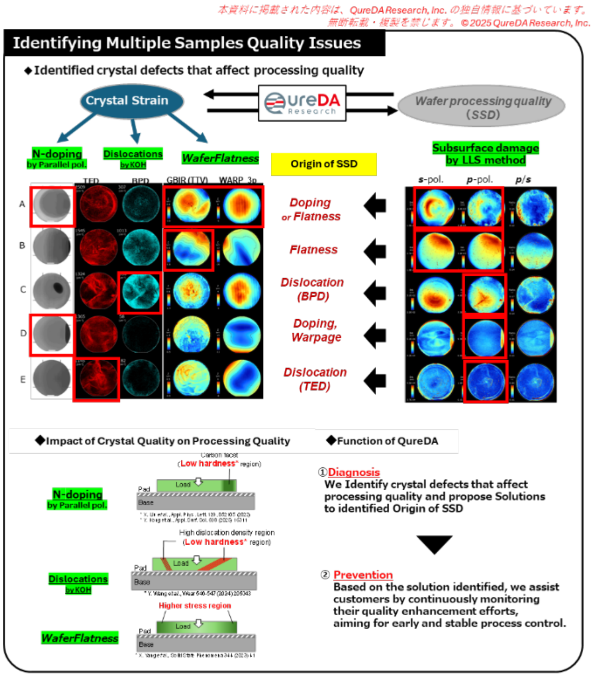

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Identifying Multiple Samples Quality Issues

◆Identified crystal defects that affect processing quality

◆Impact of Crystal Quality on Processing Quality

◆Function of QureDA

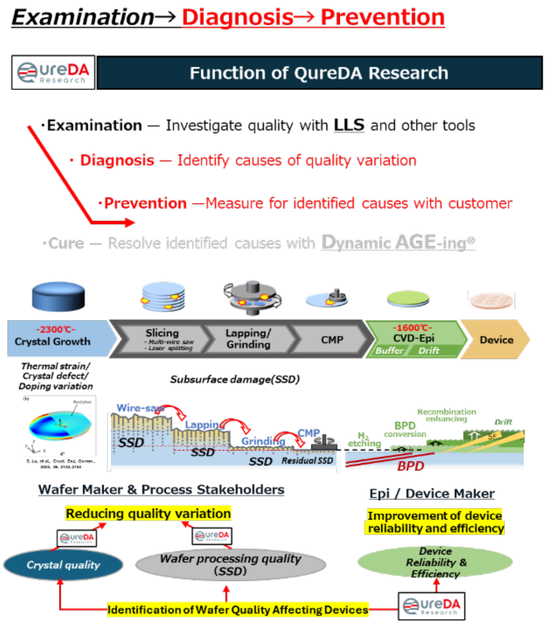
①Diagnosis
We Identify crystal defects that affect processing quality and propose Solutions to identified Origin of SSD

② Prevention
Based on the solution identified, we assist customers by continuously monitoring their quality enhancement efforts, aiming for early and stable process control.

Identifying Quality Variation Origins in Ingots Using LLS

Even wafers sliced from the same ingot can exhibit significant variations in quality.

Conventional evaluation methods often fail to identify the root causes of such variation, especially for subsurface damage (SSD).However, quantitative analysis using the Laser Light Scattering (LLS) method enables detailed visualization of light scattering behavior both at and beneath the wafer surface, providing deeper insight into the origins of SSD.For example, in wafer No.1, a circular pattern induced by mechanical processing is clearly observed,while wafer No.23 shows strong p-polarized scattering primarily caused by basal plane dislocations (BPDs), which contributes to a reduction in the correlation coefficient (r² value). These results demonstrate that LLS-based evaluation can uncover previously undetectable factors—such as BPD distribution or mechanical strain—that significantly influence wafer quality.This allows for more precise identification and control of variation within a single ingot.



Examination→ Diagnosis→ Prevention

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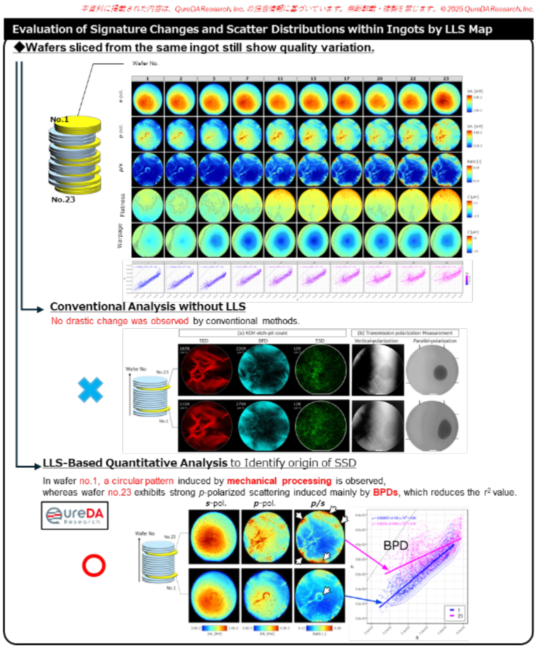

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Evaluation of Signature Changes and Scatter Distributions within Ingots by LLS Map

◆Wafers sliced from the same ingot still show quality variation.

Conventional Analysis without LLS

No drastic change was observed by conventional methods.

LLS-Based Quantitative Analysis to Identify origin of SSD

In wafer no.1, a circular pattern induced by **mechanical processing** is observed, whereas wafer no.23 exhibits strong *p*-polarized scattering induced mainly by **BPDs**, which reduces the r^2 value.

Cure Fundamental Restoration with Dynamic AGE-ing

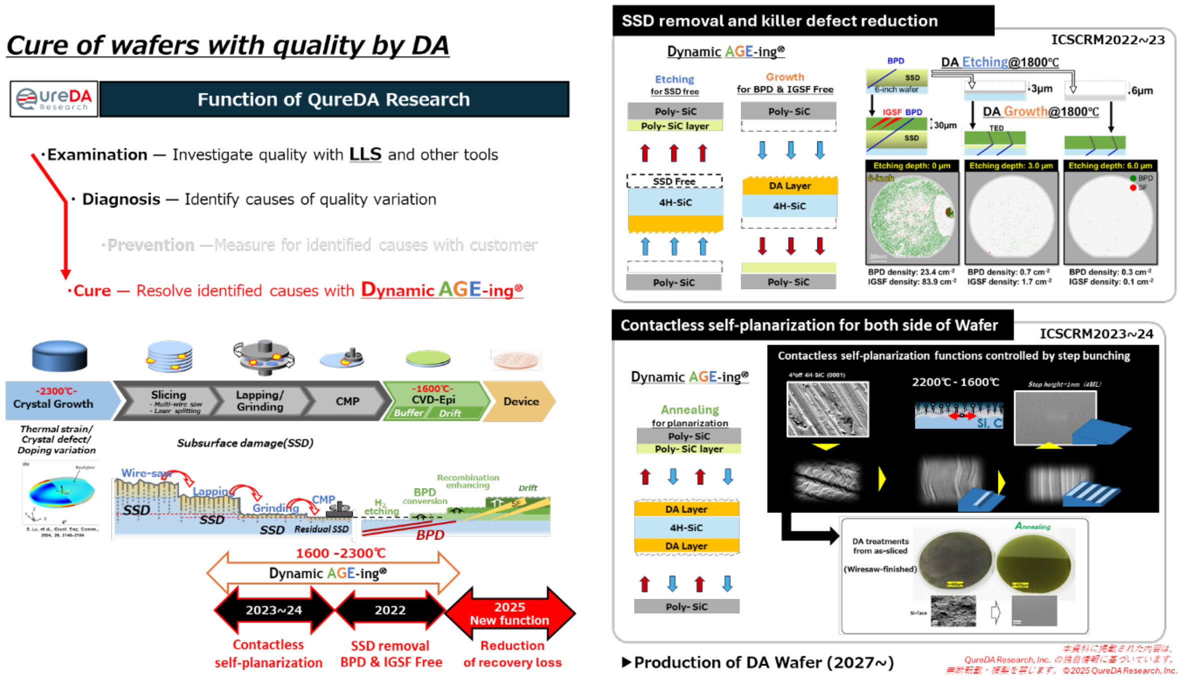
The "Cure" step refers to the process of fundamentally resolving quality issues identified during the Examination and Diagnosis phases, using Dynamic AGE-ing (DA) technology.

DA technology offers the following core functions:

▶Etching Function : Removes subsurface damage (SSD) generated during wafer processing. *(top-right figure)*

▶Growth Function : Converts basal plane dislocations (BPDs) into threading edge dislocations (TEDs), thereby suppressing the formation of stacking faults — known as killer defects. *(top-right figure)*

▶Annealing Function : Smooths wafer surface roughness through a self-planarization mechanism. When applied immediately after wafer slicing, DA alone can achieve CMP-equivalent flatness, without mechanical polishing. *(bottom-right figure)*



Cure of wafers with quality by DA

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SSD removal and killer defect reduction

Contactless self-planarization for both side of Wafer

Contactless self-planarization functions controlled by step bunching

▶Production of DA Wafer (2027~)

By integrating these functions, DA enables both quality improvement and process simplification.

At ICSCRM 2025, we reported that replacing the conventional CVD-epitaxial buffer layer with a DA layer helped suppress carrier lifetime degradation, contributing not only to defect reduction (e.g., BPD suppression) but also to enhanced device performance.In collaboration with Toyota Motor Corporation, we are preparing for mass production of DA wafers by 2027, aiming to deliver a breakthrough innovation in quality across the SiC supply chain.