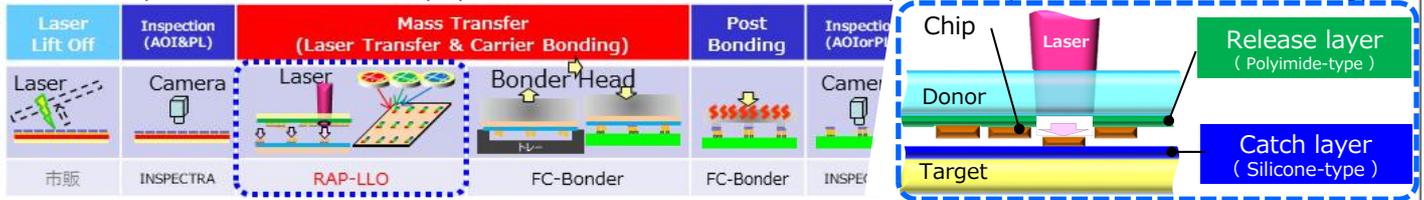


Analysis for manufacturing technology of micro LED - Optimization of laser transfer conditions -

In the manufacturing process of micro LED displays, the laser process is very effective for accurate and fast transfer of micro chips. However, it is necessary to select the appropriate laser wavelength and energy for high-precision transfer. We introduce analysis methods that can evaluate surface contaminations and damage in order to select optimal process conditions.

RAP-LLO Toray Engineering Co., Ltd.

Toray Engineering Co., Ltd. supplies a wide variety of equipment related to the micro LED manufacturing process, and has developed a new technology, RAP-LLO (Random Access Patterned - Laser Lift Off). The new technology, RAP-LLO is capable of transferring only selected chips at a high speed of 10,000 chips per second, and is expected to become an indispensable technology for the widespread use of micro LED displays in the market. We will introduce examples of analysis related to this new technology.



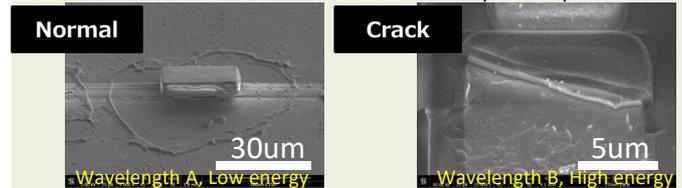
Condition of laser transfer

Daring to experiment under inappropriate condition

Laser	Wavelength A	Wavelength B
Low energy	Transferred	Not released
High energy	Transferred	Cracking

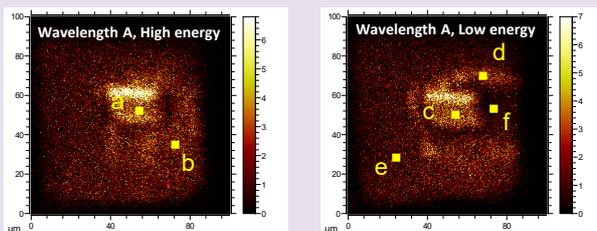
Morphological observation (SEM)

Chip cracks are observed under inappropriate condition. High resolution SEM observation is effective in determining the cause of defects and can contribute to yield improvement.

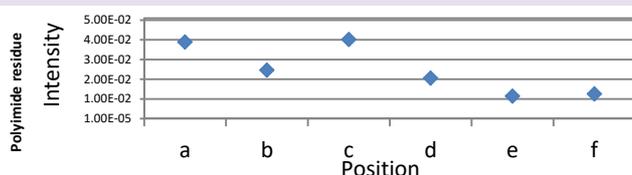


Surface-contamination evaluation (TOF-SIMS)

TOF-SIMS can obtain chemical structure of organic materials with high sensitivity and high spatial resolution. It is an ideal method to evaluate the matching of laser conditions with release materials and catch materials.



Distribution of polyimide residue



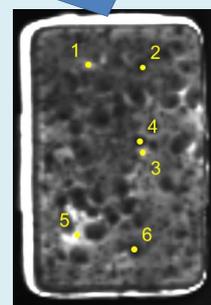
Contamination were found on the top surface of the chip even in the normal transfer process, and the distribution of the contamination varied among the conditions. TOF-SIMS is an important method for selecting appropriate laser conditions.

Damage evaluation (Cathodoluminescence)

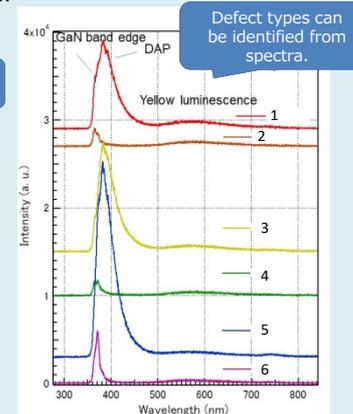
Cathodoluminescence (CL) can evaluate damage (defects) on the surface of semiconductor chips with high sensitivity and high spatial resolution, and is a very effective method for evaluating micro-sized LEDs.

Wavelength A, High energy

Confirmation of dark spots that cannot be seen with SEM.



CL image 5um



CL spectrum

Defect types can be identified from spectra.

Many dark spots were observed under all the normal transfer conditions. It is conceivable that these could have occurred during the lift-off process of the LED chip from the sapphire substrate. CL method can evaluate residual defects in chips with high sensitivity, it can be used for process improvement.

Toray Research Center will contribute to accelerate the development of micro-LEDs by utilizing the latest analysis techniques and the more than 40 years of experience we have accumulated.