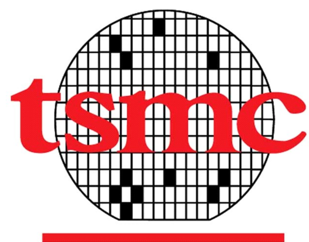

Characterization of SiO_2/Si Interface Quality by Photoluminescence

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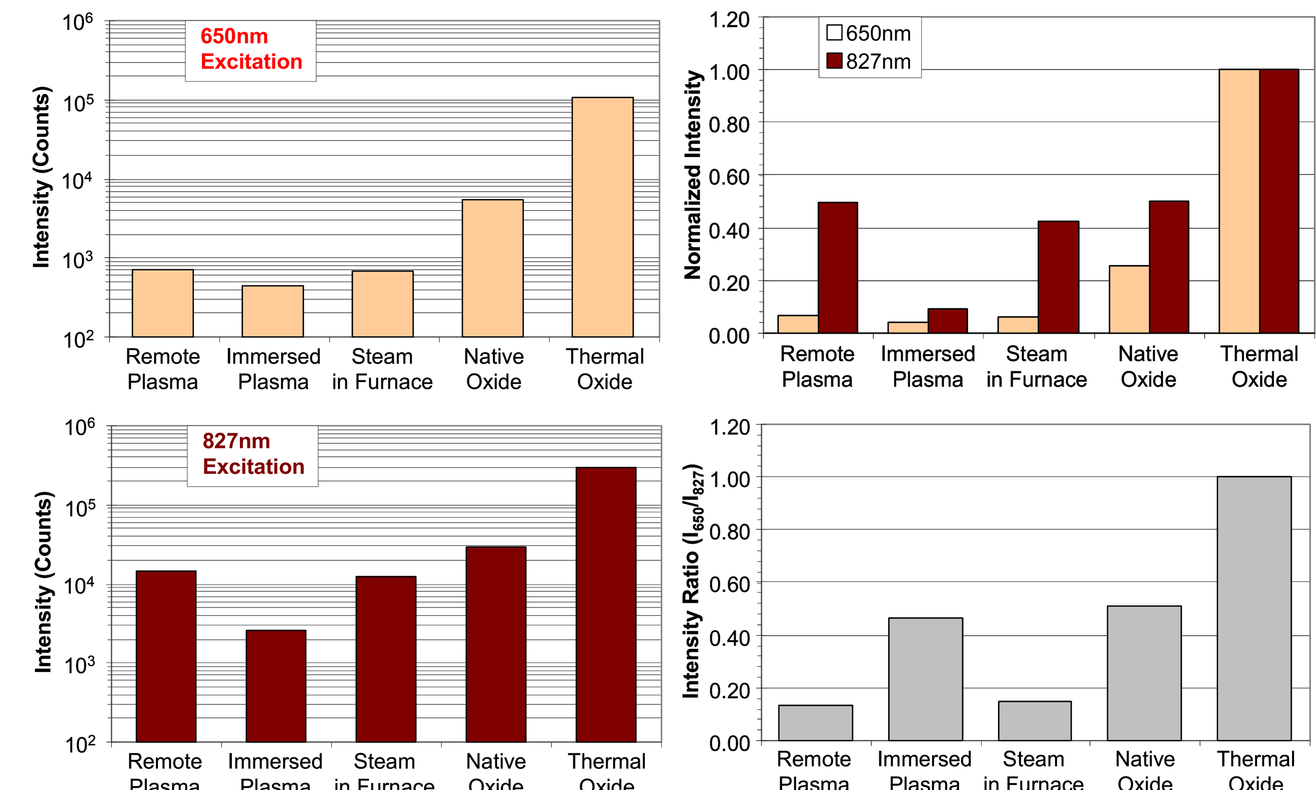
Objective:

- Development of nondestructive optical characterization technique for dielectrics/Si interface quality towards in-line process and equipment monitoring

Sample Preparation:

- Ultra-thin SiO_2 films were grown by plasma oxidation and steam oxidation in furnace at low temperatures at or below 350°C.
- For comparison, Si wafers with native oxide and high temperature (1050°C) dry oxide films are also prepared.

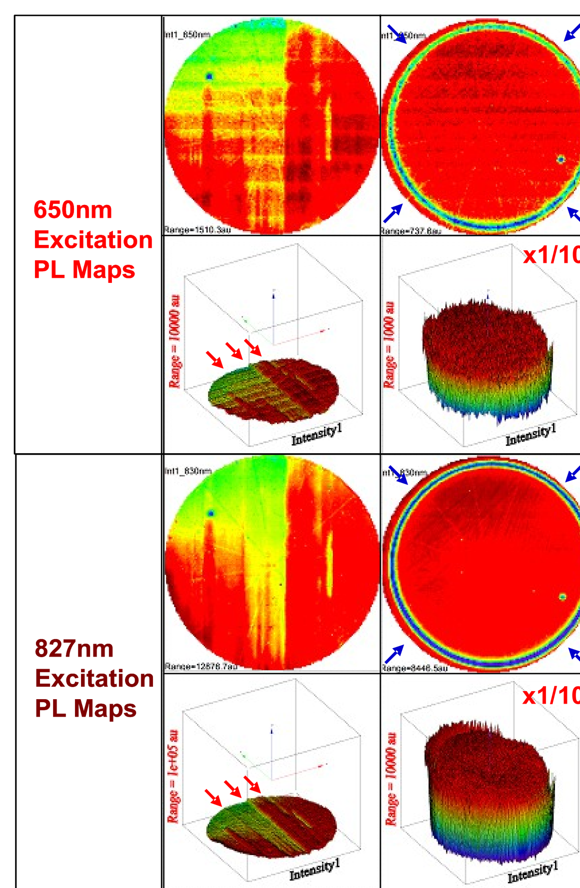
Wafer ID	SiO_2 (nm)	Preparation Technique
Wafer A	2.0	Remote Plasma at 350°C
Wafer B	1.5	Immersed Plasma at RT
Wafer C	2.0	Steam in Furnace at 350°C
Wafer D	1.4	Native Oxide
Wafer E	50.2	Thermal Oxide Grown at 1050°C



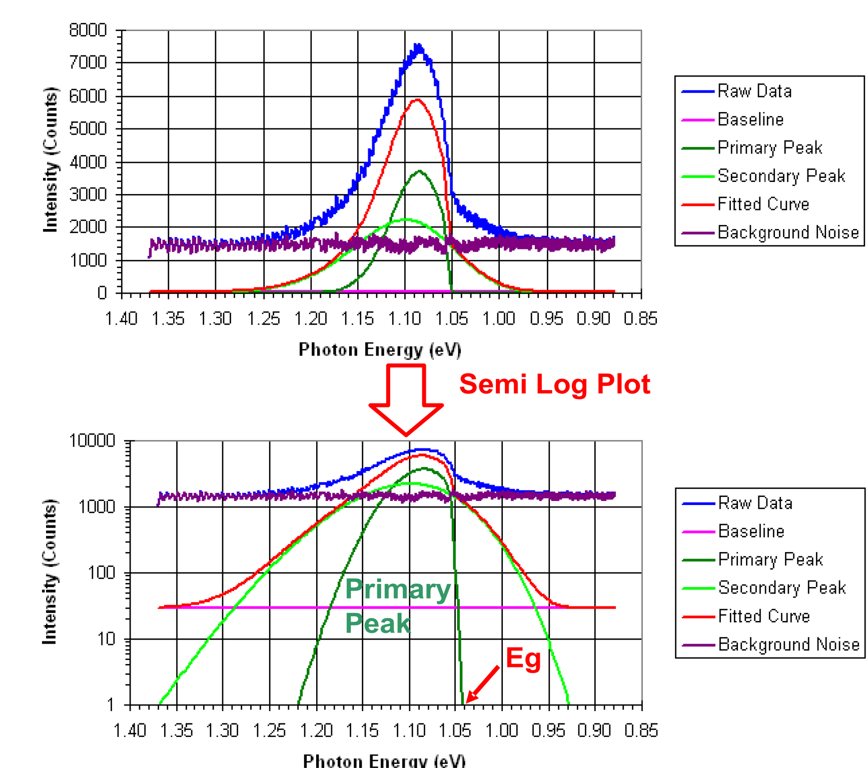
Characterization Technique:

- Multiwavelength Room Temperature Photoluminescence (RTPL)
  - 532 nm
  - 650 nm
  - 827 nm

RTPL Mapping Examples of Metal Contaminated Wafers

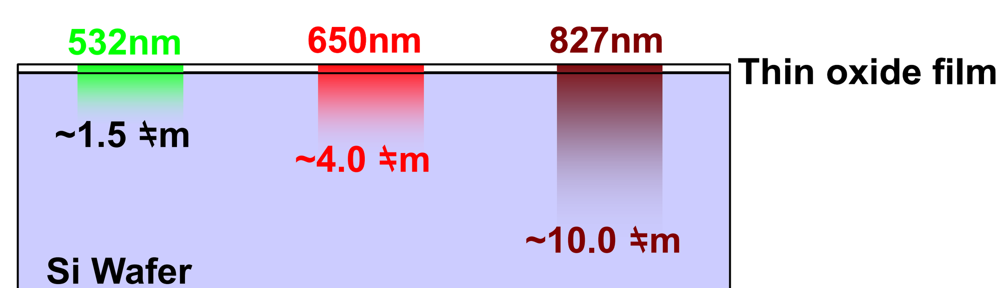


Bandgap Estimation from Room Temp. PL Spectra



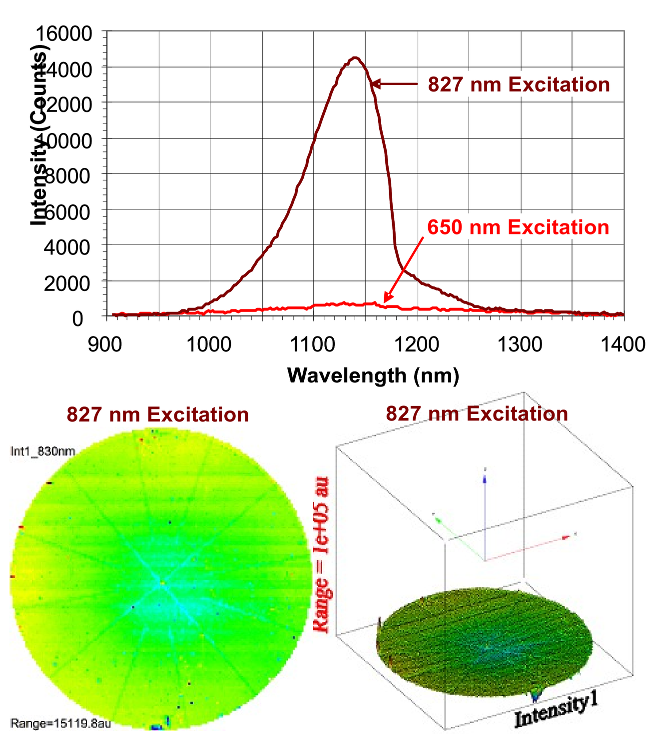
For characterization of bandgap variation and dopant activation, PL spectra measurement is required.

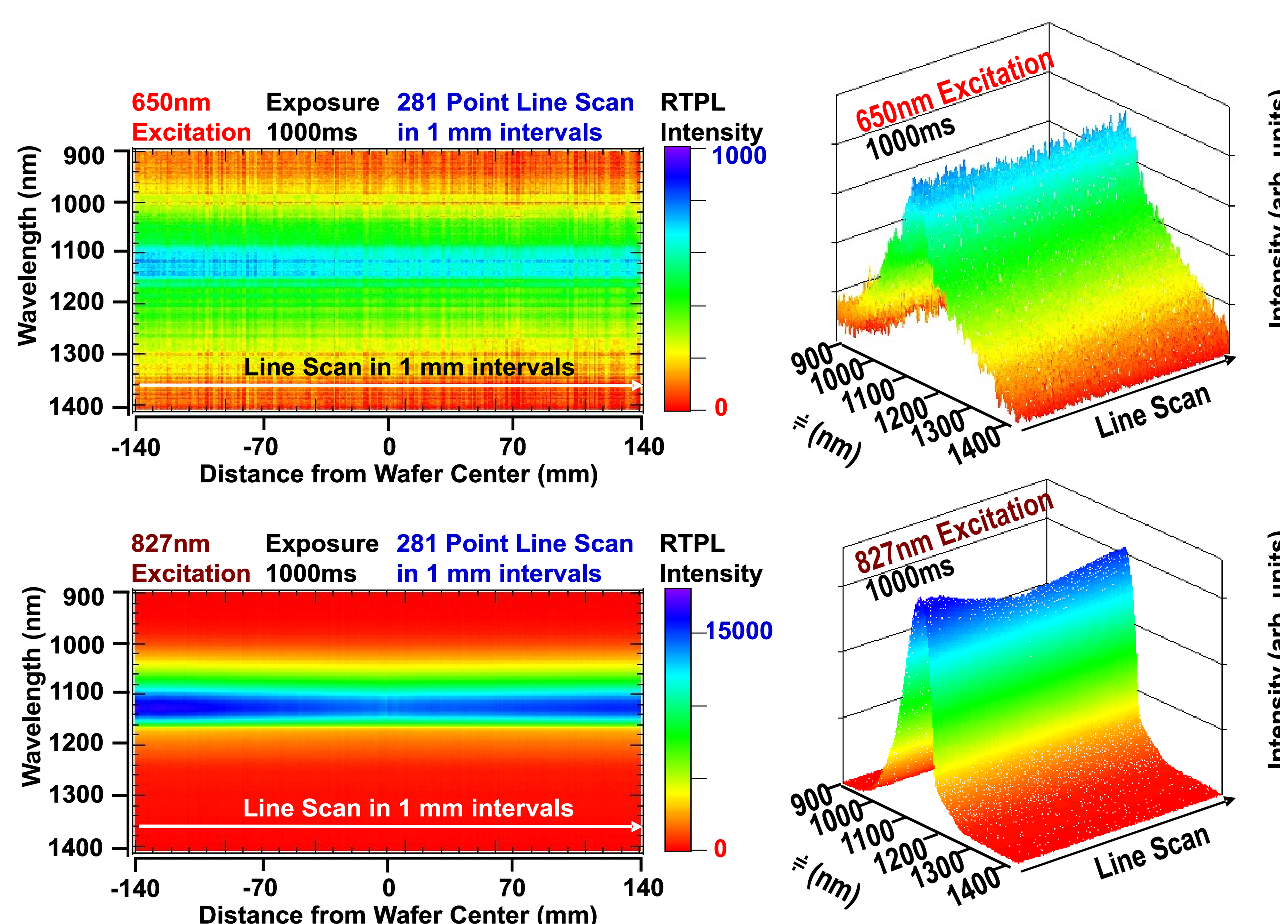
Excitation Wavelength vs. Probing Depth



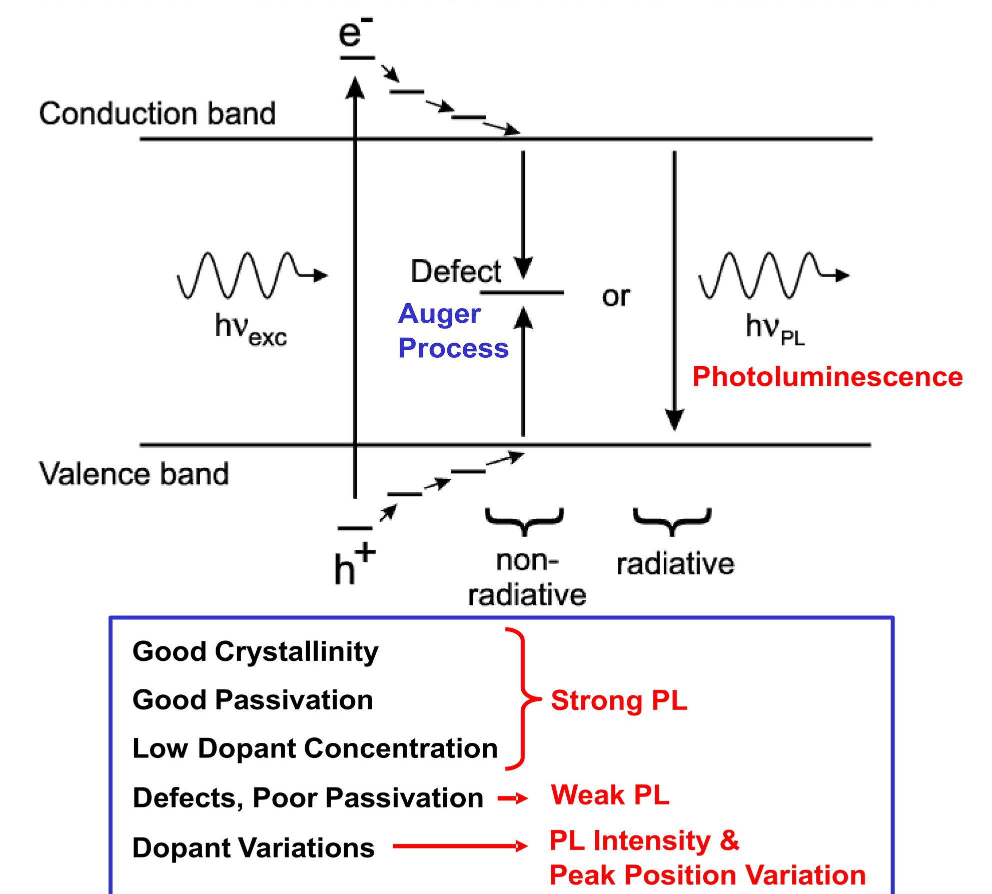
RTPL Characterization Results:

Wafer A: Remote Plasma Oxide

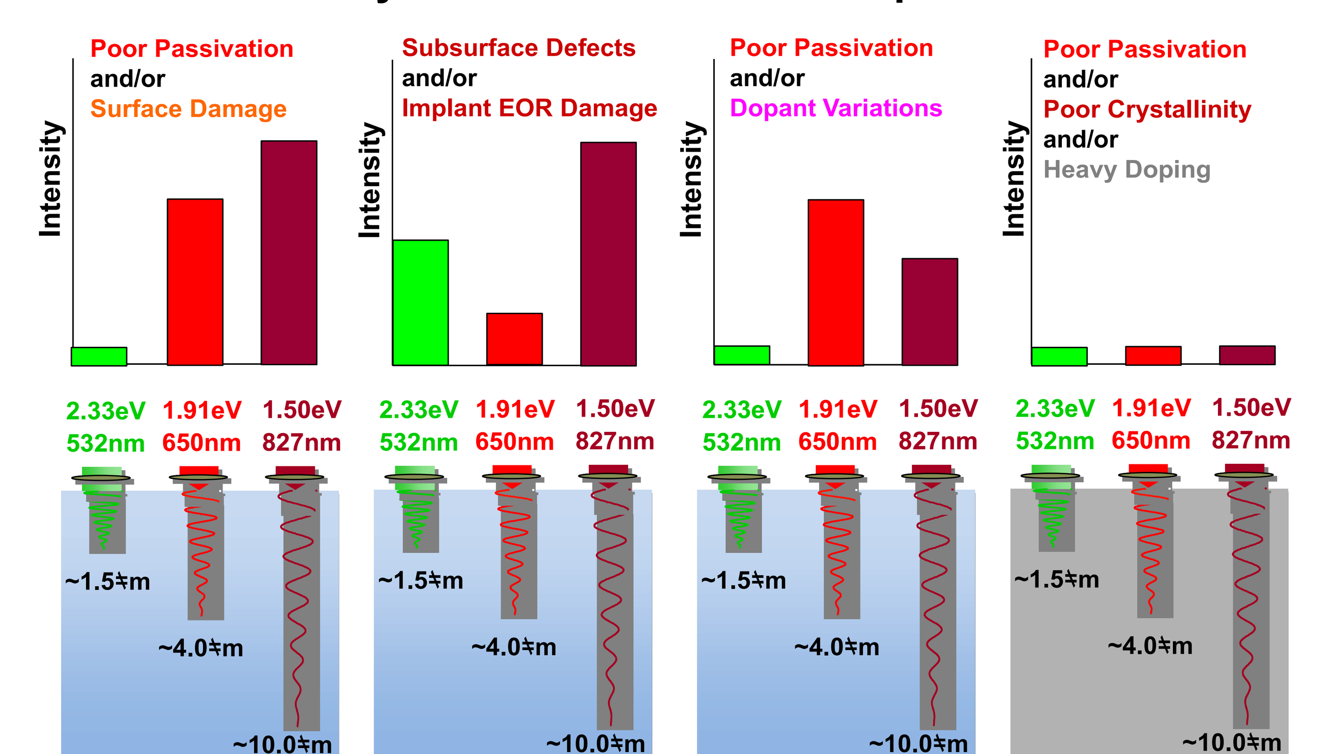




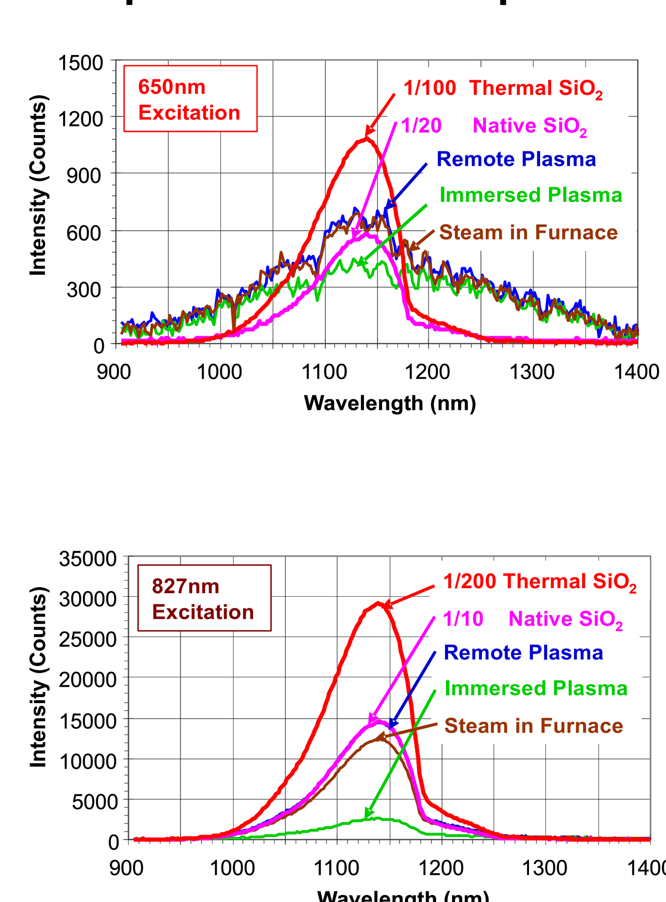
Radiative and Non-Radiative Recombinations

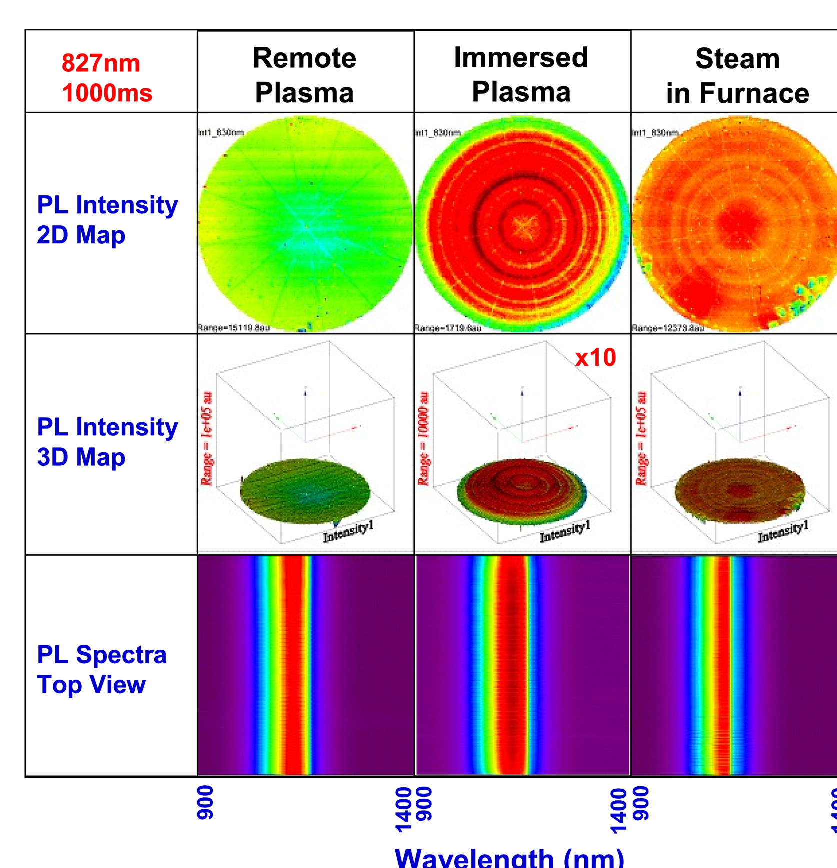


PL Intensity Patterns and Their Interpretations



RTPL Spectra & Wafer Maps





Summary

Multiwavelength RTPL measurements were performed on ultra thin low temperature oxide films on Si wafers. We have found that the RTPL characterization results reflect the quality of the SiO_2/Si interface and correlates with electrical properties of devices fabricated on the same structures. The RTPL technique can be very useful for in-line monitoring of low temperature oxidation processes and of the integrity of the SiO_2/Si interface.