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EpiEL Probes

Currently MaxMile provide different types of EpiEL probes to meet different application needs, which includes **Type I**, **Type IA**, **Type II**, **Type IIA**, **Type III**, **Type IIIA**, and **Type SiA.**

1. Type I EpiEL probe

Type I EpiEL probe can be used to reveal the electroluminescence characteristics of wide driving current density. Without causing catastrophic damage to the material, it can reach the equivalent driving current density far beyond the rated current density of the corresponding device. This type of probe has less accuracy in measuring the value of driving voltage, but it has its unique advantage to investigate the electroluminescence characteristics over large driving current density, such as emissive efficiency, peak wavelength or FWHM change as driving current changes. These informations can be used to optimize the high rated working condition of fabricated device as well as device structure in some laser diode development.

2. Type IA EpiEL Probe

Type IA probe has same contact size as Type I probe, but it has the capability to test wafers without activation. Usually Type I works only on well activated wafers. Due to this capability, usually Type IA reveals lower measured Vf than Type I probe from same wafer under test.

3. Type II EpiEL Probe

Compared to **Type I EpiEL probe**, **Type II EpiEL probe** uses a relatively low current density. It can be customized to the contact size close to real device. This type of probe can be used to form different size of devices in the epiwafers which could closely simulate the device working condition for each application. **Type II EpiEL probe** has excellent accuracy in measuring the value of turn-on & driving voltages and wafer-to-wafer variation. Type II usually works on well activated wafers.

Figure 1 and 2 show typical peak wavelength and FWHM characteristics measured with **Type I** and **Type II** EpiEL probes respectively which were acquired from the same location of a blue GaN LED epiwafer. Both figures indicated that the peak wavelength decreases, while FWHM increases, as driving current increases. However, from rough estimation of the value of peak wavelength and FWHM, figure 2 only reveals the small potion of peak wavelength and FWHM characteristics of figure 1. In other word, Figure 1 covers much wider equivalent driving current density than Figure 2 does. Of course, at low current density, Figure 2 reveals more detailed information than Figure 1 does. Figure 2 also indicates that, at the very beginning of emitting light, the peak wavelength increases while FWHM decreases as driving current increases.

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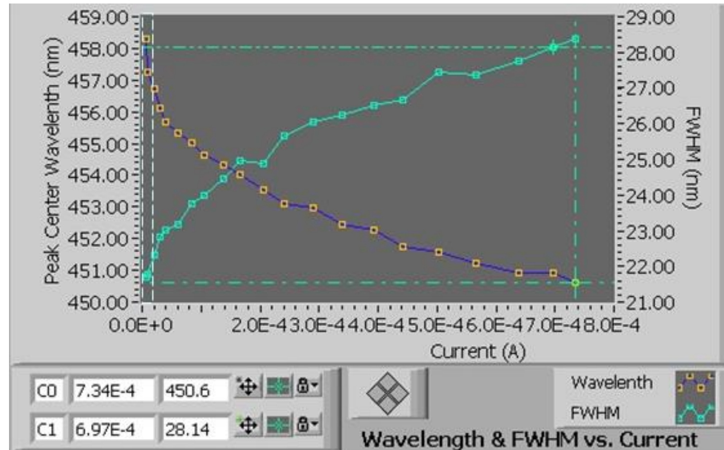

Figure 1, Peak wavelength and FWHM characteristics, measured with Type I EpiEL probe

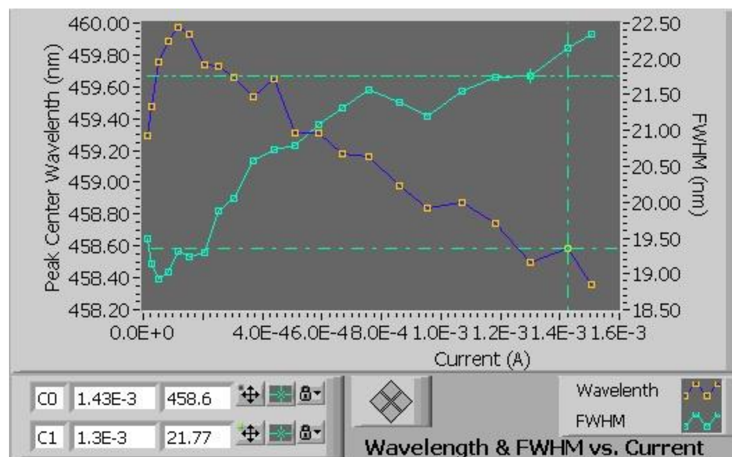

Figure 2, Peak wavelength and FWHM characteristics, measured with Type II EpiEL probe from the same spot of the sample used in Figure 1; this measurement reveals only small potion of peak wavelength and FWHM characteristics of figure 1 (marked with dashed lines)

4. Type IIA EpiEL Probe

Type IIA probe has same contact size as Type II probe, but it has the capability to test wafers without activation. Usually Type II works only on well activated wafers. Due to this capability, usually Type IIA reveals lower measured Vf than Type II probe from same wafer under test.

Figure 3 shows test results from wafer before and after activation, which indicating typical the LIV and reverse change. Using both Type II and Type IIA probe, EpiEL system can be used to optimize activation process.

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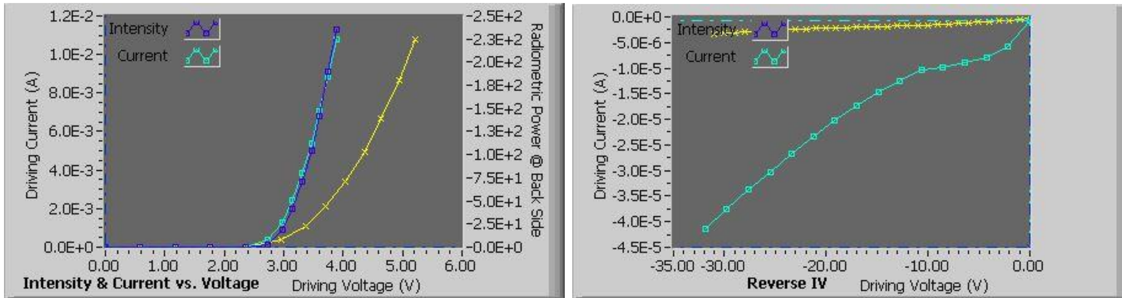

Figure 3, LIV (left) and reverse (right) revealed by EpiEL, yellow curve indicating test results from un-activated wafer, while blue curves from activated wafer.

5. Type III EpiEL Probe

Probe material is the same as Type II material while contact area is half.

Note: *Type III was called Type IIC previously.*

6. Type IIIA EpiEL Probe

Probe material is the same as Type IIA material while contact area is half.

Note: *Type IIIA was called Type IIB previously.*

7. Type SiA EpiEL Probe

Type SiA is specially designed to test GaN-on-Silicon wafers which use similar probe material as Type IA probe.

Except Type SiA probe, most types of probes can be used without any change of hardware configuration of EpiEL system. Type SiA probe needs a special version of EpiEL system which is designed to support test GaN-on-Si LED wafer.

Though different EpiEL probes have different performance in EpiEL measurement, the electroluminescence characterization results provided by both types of probes, as well as real device fab, are practically convertible to each other through equivalent driving current density.

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