

850 nm VCSEL Epiwafer

Descriptions

Two- or three-inch epiwafers grown by MOVPE are available for 850nm vertical cavity surface emitting laser (VCSEL) fabrication. The active region comprises three quantum wells of GaAs/Al_{0.3}Ga_{0.7}As sandwiched by AlGaAs layers to form a resonant cavity between P- and N-DBR mirrors. Since N-DBR has higher reflection, the light is emitted from the P-DBR mirror to form the laser beam. LandMark offers two types of wafers for making either ion-implanted or oxide-confined lasing aperture. **Figure 1** shows the epiwafer layer structure with an Al_{0.95}Ga_{0.05}As oxidation layer. **Figure 2** shows the schematic of an oxide-confined VCSEL chip. It features low threshold current, high laser-fiber coupling efficiency, ease of 2D array formation, and high modulation frequency. The 850 nm VCSEL dominates the short reach and high speed data networks such as the Gigabit Ethernet and Fibre Channel.

P ⁺ -GaAs
P-Al _{0.12} Ga _{0.88} As
Al _{0.12} Ga _{0.88} As/ Al _{0.3} Ga _{0.7} As P-DBR(22 pair)
Al _{0.3} Ga _{0.7} As
AlGaAs
3 QWs Active Region
AlGaAs
Al _{0.12} Ga _{0.88} As/ Al _{0.3} Ga _{0.7} As (34 pair)
N-GaAs Buffer
N-GaAs Substrate

FIG.1

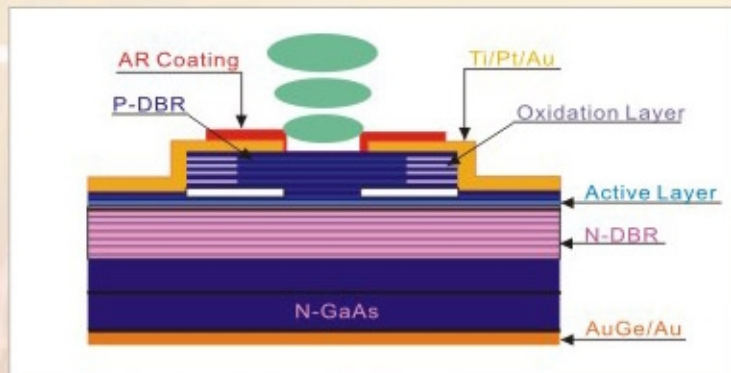


FIG.2

Wafer Characterization

The VCSEL epiwafers are characterized by PL, Reflectivity, DCXD and E-CV tests. The PL test result of a typical 850 nm VCSEL epiwafer without P-DBR and the above layers is shown in **Figure 3**. Because the QW material is GaAs and is ~8 nm thick, the wavelength uniformity is excellent. The PL wavelength maximum variation is only 3nm across the 2-inch wafer. Due to the high reflection from N-DBR beneath the active region, the FWHM is as narrow as 17 nm (~30 meV).

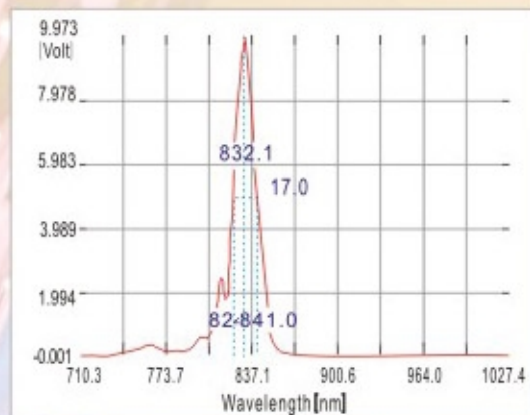


FIG.3

850 nm VCSEL Epiwafer



w w w . l m o c . c o m . t w

EPIWAFERS FOR PHOTODETECTOR (PD)

EPIWAFERS FOR VISIBLE-LIGHT LASER DIODE (LD) and RCLED

EPIWAFERS FOR LASER DIODE

Wafer Characterization

The reflectivity spectrum of five distinct points, Center-Left-Right-Up-Down, on a 2-inch wafer, are shown in **Figure 4**. A telon dip can be seen near the center of the stop-band. The stop-band center wavelength varies from 849.6nm to 855.1nm for these 5 points. The stop-band width is about 85nm .

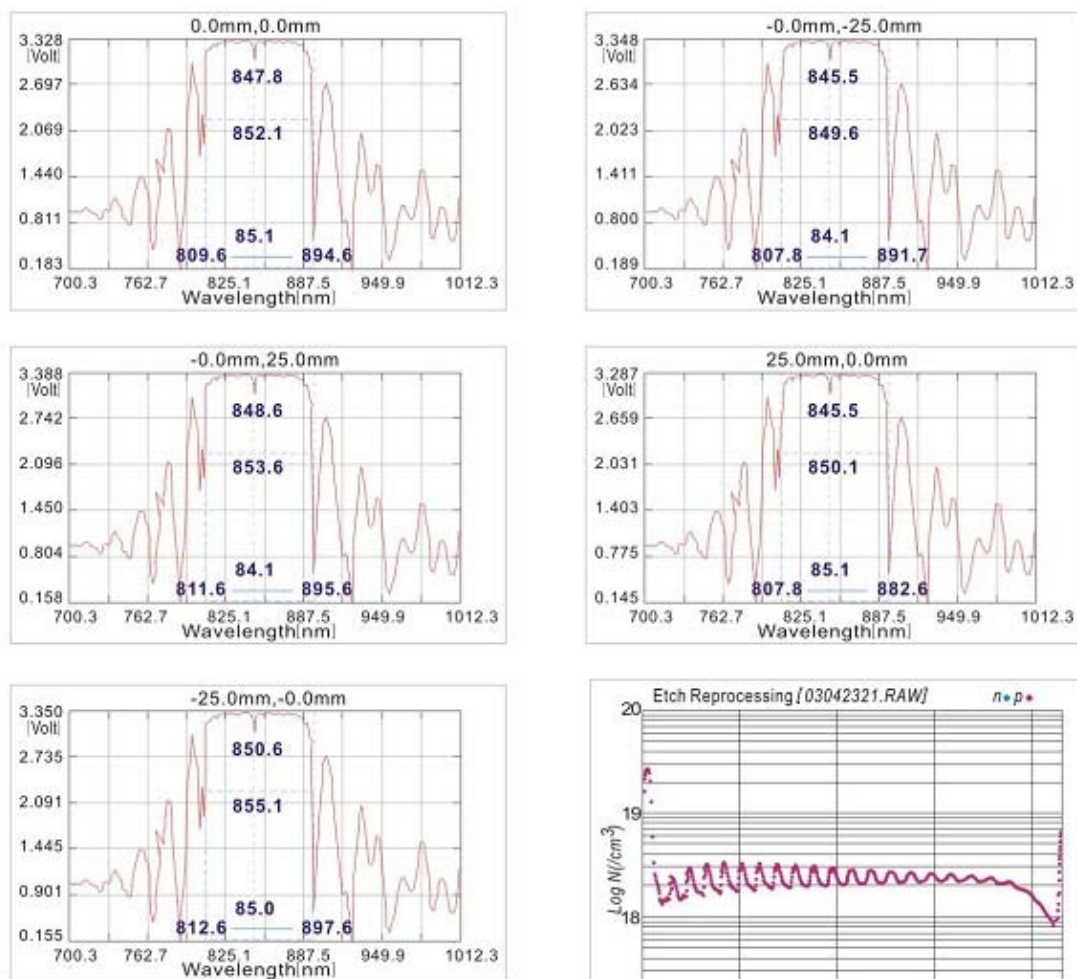


FIG.4

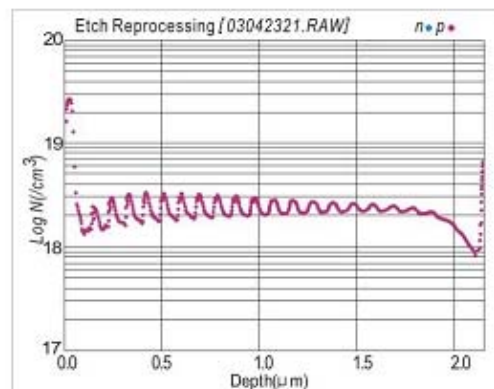


FIG.5

Figure 5 shows the concentration depth profile measured by E-CV method on P-type material. The 20 periods P-DBR comprises three Carbon doped materials:

- (a) $Al_{0.9}Ga_{0.1}As$,
- (b) GRIN- $AlGaAs$ in high-to-low and low-to-high,
- (c) $Al_{0.12}Ga_{0.88}As$ grown in repetition.

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Wafer Characterization

Figure 6 shows a typical DCXD rocking curve measured at center of an epiwafer. One-period thickness of P-DBR layer is calculated by observing satellite peaks in this figure.

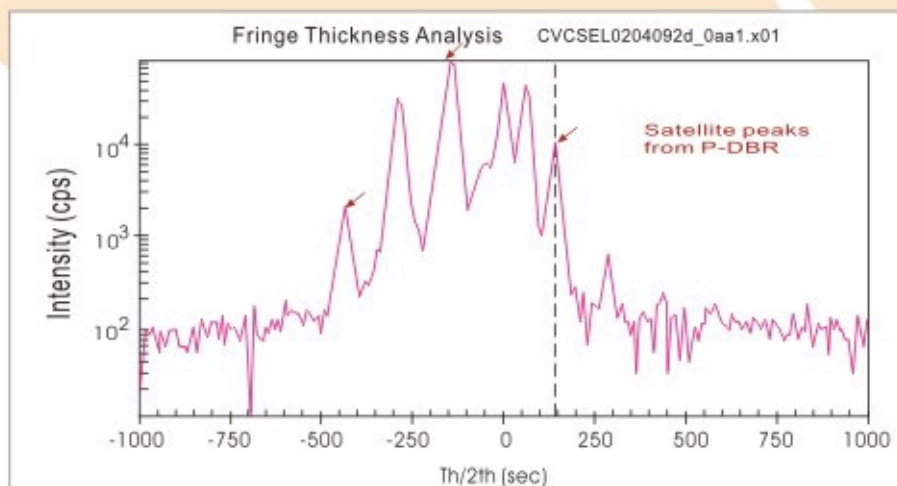


FIG.6

Typical Epitaxial Capability

Parameters	Values
SB center	± 10nm of specified value
Thickness uniformity	Better than ± 2.5%
PL Wavelength uniformity	~ ± 1.5 nm at inner 40mm
Doping control	30%
P-AlGaAs doping (cm ⁻³)	C doped; 5E17 to 1E20
N-AlGaAs doping (cm ⁻³)	Si doped, 1E17 to 5E18
Al composition in Al _x Ga _{1-x} As	95% to 5%
P ⁺⁺ - GaAs doping (cm ⁻³)	C doped, >1E19
Defect density control (Diameter)	<100cm ⁻² (D>10um)

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Typical Device Performance

Figure 7 shows the typical L-I-V curves of 5 VCSEL devices. The lasing aperture is defined by the oxidized $\text{Al}_{0.95}\text{Ga}_{0.05}\text{As}$ layer. The typical device parameters are shown in the following Table.

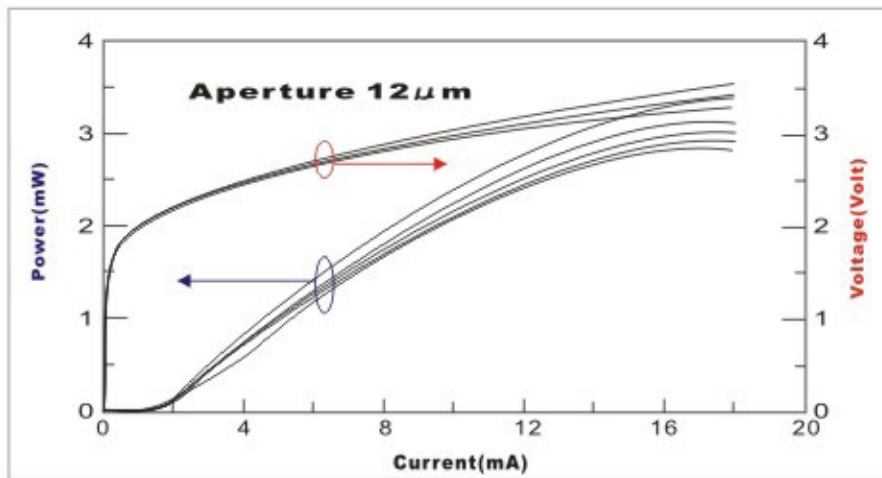


FIG.7

Parameter	Symbol	Typical
Threshold current @ 25°C	I_{th}	< 4 mA (Aperture ~ 10 μm)
Wavelength	λ	845–855 nm
Slope efficiency	η	> 0.3 W/A
Serial resistance	R_s	< 50 Ω
Operating temperature	--	0–80°C
Type	Oxidation Confined Aperture	

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