SHOWA DENKO K.K. **Ver.10 material 2019/9/30**

SiC epitaxial wafer

High Grade Epi Specification

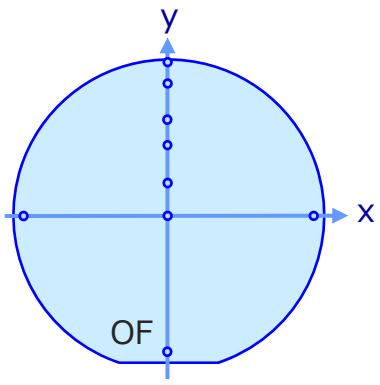
Items	Specification	Tolerance	Typical	Remark
Diameter	6"(150mm)	-	-	
Poly-type	4H	-	-	
Surface	(0001)Si-face	-	-	
Off-orientation	4deg-off	-	-	
Conductivity	n-type	-	-	
Dopant	Nitrogen	-	-	
Carrier Concentration	1E15-3E16	±12%～±20%	±8%	All Meas, points
Epi Thickness	5um～30um	±8%～±10%	±6%	All Meas, points
PDD	≦2.0/cm^2	-	0.3/cm^2	(THK5um～30um)
BPD 2mm yield	>92%	-	98%	Up to request

Notes

1) Other dimensional specifications are similar to definition in SEMI M12

2) Measurement points for Thickness and Carrier Concentration

15mm pitch 9pts (EE = 4mm)
Thickness by FT-IR
Carrier Concentration by Hg-CV



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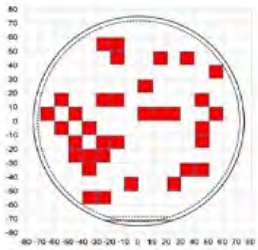
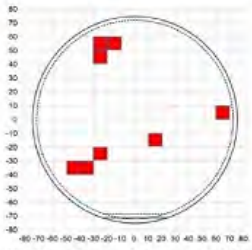
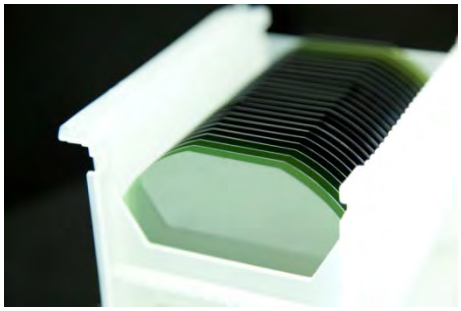
SHOWA DENKO K.K. **Ver.10 material 2019/9/30**

SiC epitaxial wafer
2nd Generation High grade epi

	High-Grade Epi (HGE)	2nd Generation High-Grade Epi (HGE-2G)
【Improvement on defects】 Ratios of successful formulation of 10mm square chips	 Ratio of good chips: 74% Bad chips	 Ratio of good chips: 94% Bad chips
【Reduction in BPD】 X-ray topographical image of mother plate  BPD density: More than 5,000/cm^2 BPDs are in red	After epitaxialization (PL-NIR)  About 4 BPDs/cm^2	After epitaxialization (PL-NIR)  About 0.1 BPDs/cm^2

6inch n-type Epi (10um thickness)

Launched in 2019 Aug



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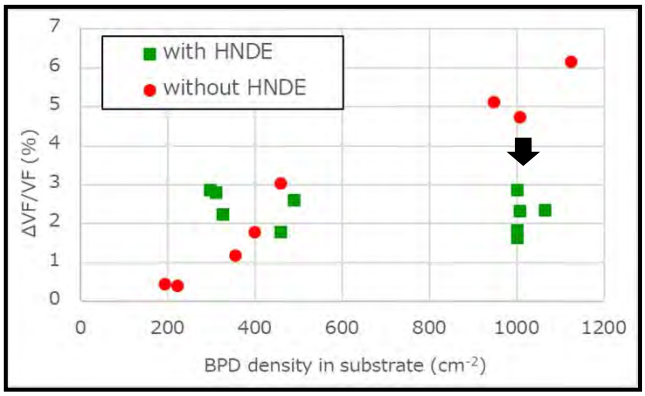
SHOWA DENKO K.K. **Ver.10 material 2019/9/30**

SiC epitaxial wafer
Highly N-doped Epi layer (HNDE)

Epi : Drift Layer
Epi : Highly N-doped Epilayer
Epi : n^+ Buffer Layer
n^{++} Substrate

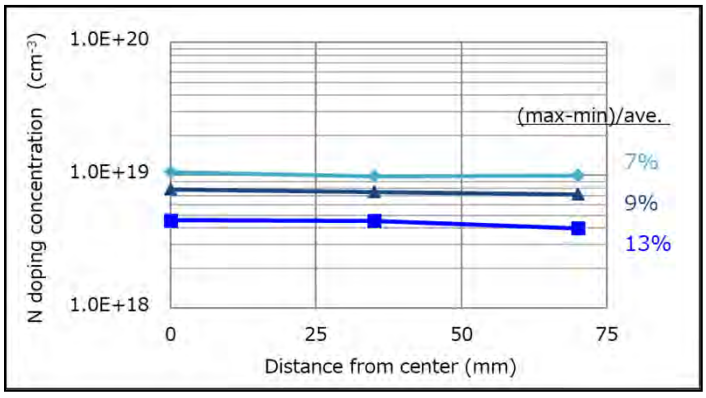
Restraint of BPD expansion by remaining minority carrier due to shorter carrier life time using highly HNDE.
※Tawara, et al Mater. Sci Forum 897 (2017) 419.

V_f shift of PiN diodes
As function of BPD density in substrate



※after application of 960 A/cm^2

N doping uniformity on 150mm wafer



※SIMS data

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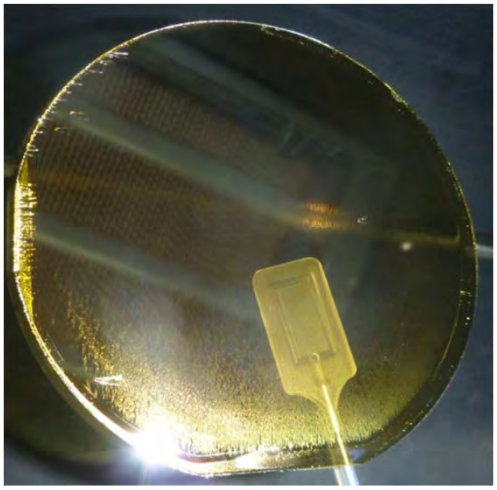
SHOWA DENKO K.K. Ver.10 material 2019/9/30

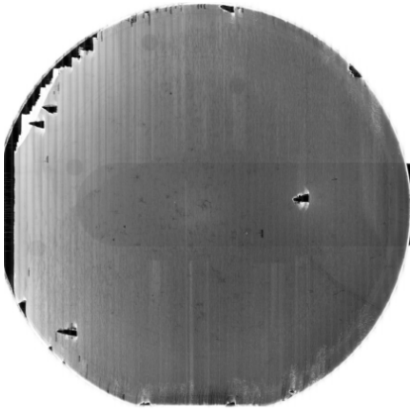
SiC epitaxial wafer
Thick epi performance

4inch n-type (~280um thickness)



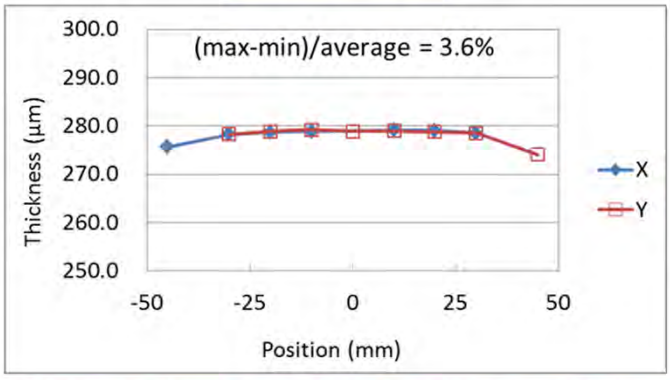
Only one triangle defect can be detected by visual

PL measurement

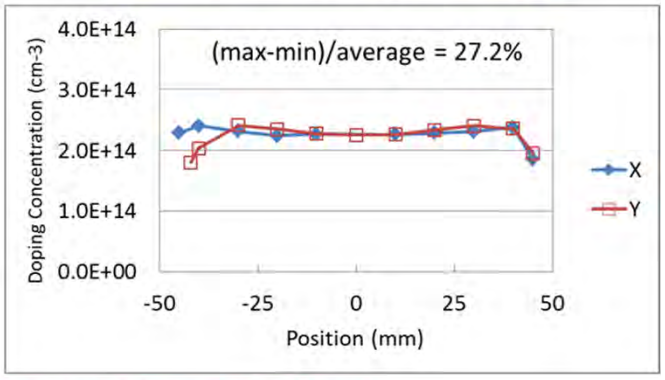


No BPD propagated from the substrate

Thickness



Carrier Concentration



*) FTIR thickness evaluation can not be applied at very out side area (≧ 40mm)

Thicker layer sample shows good distribution on layer thickness and carrier concentration. Surface defect and BPD performance are also improved significantly even with 280um of thickness.

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