

# Commercialization of GaN Based Field Effect Transistors

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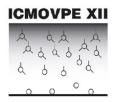
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### GaN HEMT Epi Grown on 2-inch SiC:

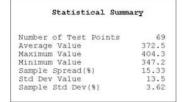
#### Wafer to Wafer R<sub>s</sub> Uniformity Measurement

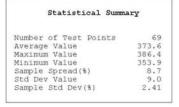


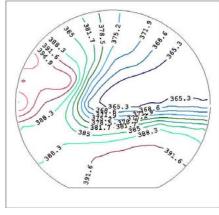
- Tailored Nucleation process to be independent of substrate surfaces or manufacturer.
- Ability to use multiple vendors substrates simplifies supply chain.
- Four GaN HEMT on SiC Wafers Grown in Same Epi Growth Run.
  - ➤ Multiple substrate vendors (both 6H [Vendors 2-3] and 4H [Vendor 1]) represented.
  - ➤ Wafer to Wafer Uniformity of 3%

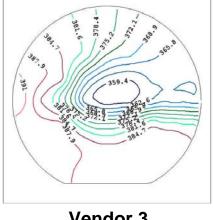
Statistical Summ	ary
Number of Test Points	69
Average Value	382.0
Maximum Value	404.7
Minimum Value	361.1
Sample Spread(%)	11.42
Std Dev Value	11.9
Sample Std Dev(%)	3.11

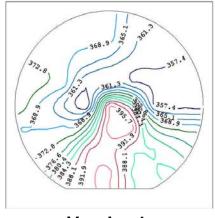
Statistical Summ	ary
Number of Test Points	69
Average Value	378.5
Maximum Value	395.6
Minimum Value	354.7
Sample Spread(%)	10.81
Std Dev Value	10.8
Sample Std Dev(%)	2.86

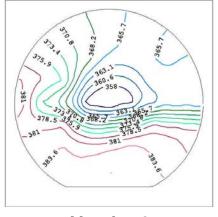












Vendor 1

Vendor 3

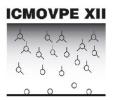
Vendor 1

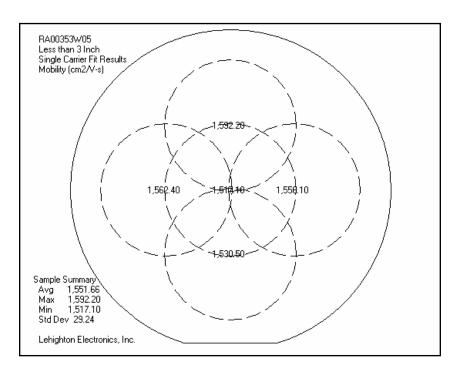
Vendor 2

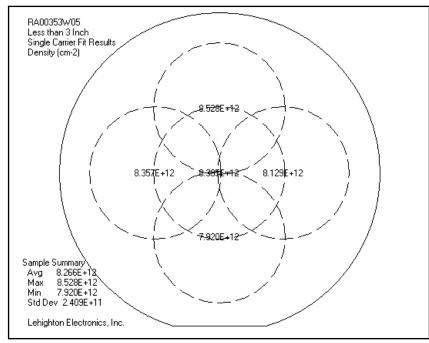


## GaN HEMT Mobility Measurement:

Lehighton Mobility Measurement Results







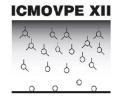
#### Standard GaN HEMT Structure Grown at RFMD exhibits:

- Mobility data measured is quite uniform,  $\sigma = 1.8\%$ .
- Sheet charge density ( $n_s$ ) measured is quite uniform,  $\sigma = 2.9\%$ .

Measurement Courtesy of Lehighton Electronics, Inc.



## GaN HEMT Mobility Measurement:



#### From PCM Data After RFMD Wafer Fabrication

						_		
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				416				(
				0.433				
	/			1030				\
/ 1		-2,2	-1,2	0,2	1,2	3,2		. \
/	307.5	474.6	377.2	395.2	405.7	407.6		
	0.901	1.01	1.09	1.08	1.03	0.9		
	2250	1310	1520	1470	1490	1700		
	-3,1	-2,1	-1,1	0,1	1,1	2,1	3,1	
	404.2	399.3	371.3	360.4	379.7	388.2	483.5	
	0.99	1.13	1.17	1.18	1.15	1.07	0.8	
	1550	1380	1430	1470	1440	1510	1630	
	-3,0	-2,0	-1.0	0,0	1,0	2,0	3,0	
	412.1	369.8	363.4	369.4	361.2	205.8	514.7	
	0.954	1.1	1.14	1.13	1.13	1.42	0.76	
\	1590	1530	1510	1500	1530	2140	1600	/
	-3,-1	-2,-1	-1,-1	0,-1	1,-1	2,-1	3,-1	
		396.7	381.9	375.4	379.8	406.8	,	
`		1.02	1.07	1.07	1.05	0.96		
		1550	1530	1550	1560	1590		
		-2,-2	-1,-2	0,-2	1,-2	2,-2		

Mobilities as high as 2250 cm<sup>2</sup>/V·s have been measured on RFMD grown material:

- High mobility attributed to atomically abrupt AlGaN/GaN interfaces.
- Average n<sub>s</sub> of 1.1x10<sup>13</sup> cm<sup>-2</sup>.
- Average μ of 1550 cm<sup>2</sup>/V·s.
- 70% of sites measured have  $\mu$  > 1450 cm<sup>2</sup>/V·s.
- High mobility regions to be sent out for independent third party evaluation.
- Shows good correlation with data measured externally at Lehighton Electronics, Inc on Model 1600 Contactless Mobility System.