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GaN-on-silicon for power conversion, who are the likely winners in the commercialization race, asks Petrov Group

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The high importance of GaN-on-Si technology for power conversion applications is by now evident, says Steve Levin, managing director for Power of the Petrov Group. It is driven by cost and performance superiority, established manufacturing infrastructure, and global market drivers for efficient energy generation, distribution and consumption. There are major commercialization efforts worldwide driven by the need for higher energy efficiency – GaN-on Si for power conversion ("GaN Power") is one of the most promising "green" technologies.

Because GaN Power technology is of national significance, the speed of adoption in power conversion applications will likely be much faster than it was for legacy silicon technologies. At present there are more than 40 semiconductor vendors and more than 20 academic and R&D institutions in the race to commercialize GaN-on-Si technology for power conversion applications.

While accelerated adoption in power conversion applications is evident, what remains elusive is use of silicon wafers and high voltage (600V to 1,200V) devices. So which vendors are likely to win the race to GaN Power commercialization?

A company that specializes in the area of commercialization of GaN-on-Si technology for power conversion applications, Venture-Q, evaluated fourteen leading vendors by seven criteria: R&D and manufacturing capabilities, financial strength, strategic importance of GaN-on-Si technology to the company, cost structure, technology capability and barriers, and patent/patent applications portfolio. Companies analyzed include Alpha & Omega, Efficient Power Conversion (EPC), Infineon, International Rectifier (IRF), MicroGaN, Nitronex, Panasonic, Power Integrations, Renesas, Rohm, Toshiba, Transphorm, Sanken, and STMicroelectronics.

Venture-Q ranks International Rectifier, Infineon, and Transphorm as the top three vendors in the discrete GaN power device domain, and International Rectifier, Sanken, and Panasonic as the top three vendors in monolithic (IC) integration, which is currently mainly addressed by patents.

Also notable is that among the fourteen vendors that Venture-Q analyzed International Rectifier and Sanken were the most active in patent generation. Of course, this is a dynamic situation that can change by a number of vendor actions.

There is still a degree of misunderstanding of technology and barriers to commercialization. An example of a misperception is the belief that LED vendors represent the closest and likely winners in the race to commercialize Power GaN. Venture-Q's analysis, in contrast, confirms that a near-term threat of LED

vendors is unfounded because it ignores the significant time-to-commercialization constraints facing those vendors, says Steve Levin.

The main roadblock to commercialization of GaN-on-Si technology for power conversion applications remains the so-called "current collapse" phenomena, which is an inherent attribute of this technology and can only be confined to an acceptable level. The current vendors of GaN power devices resort to backup strategies, including depletion mode devices in a cascode configuration with a MOSFET device, and/or SiC substrate historically used to implement RF GaN power devices.

Petrov Group: Discrete GaN power devices ranking, November 2012

Vendor	Ranking Criteria							Total Rating	Rank
	1	2	3	4	5	6	7		
IRF	7	8	8	10	8	7	9	57	1
Infineon	7	9	8	7	7	9	4	51	2
Transphorm	8	6	6	10	4	8	8	50	3
STM	7	8	8	8	7	8	3	49	4
Sanken	8	8	8	3	7	6	7	47	5
Toshiba	8	8	8	3	7	6	6	46	6
Panasonic	8	8	8	7	7	4	3	45	7
Renesas	7	7	8	7	7	4	5	45	8
Rohm	8	8	8	2	7	4	4	41	9
EPC	2	5	2	10	8	8	5	40	10
MicroGaN	4	5	3	10	6	4	2	34	11
Alpha & Omega	2	3	5	6	8	4	2	30	12
Power Integrations	4	4	6	7	7	0	2	30	13
Nitronex	7	7	3	0	6	0	0	23	14

Source: venture-Q, compiled by Digitimes, December 2012

Venture-Q ranked vendors closest to commercialization by the technology barriers they face into four major groups:

1: Vendors of RF power devices, which have only one major barrier to cross – moving from low to high voltage and from SiC (dominant substrate) to Si wafer.

2: Epi wafer vendors, which have an additional major design and manufacturing challenge – high voltage GaN power device structure design. Finding a solution to the "current collapse" phenomenon represents here an extraordinary challenge.

3: LED vendors, which are significantly more distant players in the race to commercialize the GaN-on-Si technology for power conversion applications. They face epi wafer, high voltage device design and manufacturing, and silicon substrate challenges.
4: Silicon IC, foundry vendors and silicon wafer vendors are the furthest away, because they have to make a quantum jump into the world of compound semiconductor technology.

The foundry business aspect of the competitive landscape reveals that currently only the manufacturing business model is applicable to GaN-on-Si power technology for power conversion applications. Standard type foundry services, in contrast, require a comprehensive portfolio of devices, design tools, proven design methodologies, and mature manufacturing technologies.

Petrov Group: Monolithic integration (IC) of GaN power devices ranking, November 2012

Vendor	Ranking Criteria							Total Rating	Rank
	1	2	3	4	5	6	7		
IRF	7	8	8	10	7	8	9	57	1
Sanken	8	8	8	8	7	7	7	53	2
Panasonic	8	8	8	7	7	6	7	51	3
STM	7	8	8	8	7	6	3	47	4
Transphorm	8	8	6	10	4	3	8	47	5
Renesas	7	7	8	7	7	4	2	42	6
Rohm	8	8	8	2	7	2	6	41	7
Infineon	7	9	8	7	7	2	1	41	8
Power Integrations	4	4	6	8	8	9	2	41	9
Toshiba	8	8	8	3	7	2	4	40	10
MicroGaN	4	5	3	10	6	2	2	32	11
EPC	2	5	2	10	8	2	1	30	12
Alpha & Omega	2	3	5	6	8	2	1	27	13
Nitronex	7	7	3	0	6	0	0	23	14

Source: venture-Q, compiled by Digitimes, December 2012

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