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1200V SiC MOSFET (Infeneon, Wolfspeed, and Rohm) TECHNOLOGY BENCHMARK REPORT

Aug 2018. LTEC Corporation released the technology benchmark report of the latest 1200V Si C MOSFET of Infineon, Wlfspeed and Rohm. It includes the following contents; Technique for realizing high reliability operation at high temperature, Structural analysis result, Evaluation of the figure of merit from the electric property evaluation result, Cost analysis such as chip cost and wafer cost, and so on.

Report overview

The following data is insufficient in the SiC power transistor data sheet, and this report complements such insufficient parts using the correlation between physical analysis and electrical characteristics.

1. Off-drain leakage current voltage and temperature dependency
2. Threshold voltage DIBL (Drain Induced Barrier Lowering), drain voltage dependency
3. Short circuit (short circuit, SC) capacity
4. The thermal impedance of short pulse time (1 us to 100 us)

Analysis summary

- The SiC MOSFET realizes about 1/20 in switching energy for the Si - IGBT used for reference. The simulated maximum switching frequency are 16 kHz for Si-IGBT and 200-400 kHz for SiC MOSFET.
- Despite the high threshold Vth, the company C SiC has the lowest RONxA at high temperature(644 mΩ · mm 2) . It is nearly twice as 1168 mΩmm 2 againt the company A SiC.
- It is predicted that the on-resistance (RONxA) trend per unit area will continue the reduction rate of 30% / 3 years.
- We estimate wafer cost and average selling price ASP) of those three companies in this report.

18G-0008-1

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Table of Contents

2.5 Table 4: Current status of SiC devices and module manufacturers (as of April 2018)

No.	Company	LTEC Report?	Epi Wafer	Device Chip	Module	Comments
1	WOLFSPEED (CREE)	Yes				
2	ROHM	Yes	Si (su			latively 8).
3	MITSUBISHI Electric	Yes				
4	Fuji Electric	Yes				
5	Hitachi					
6	Infineon	Yes				
7	STMicro	Yes				power card.
8	MicroSemi	Yes				
9	IXYS→ LITTELFUSE	Yes				
10	General Electric (GE)					odule,
11	United SiC Corp	Yes				
12	X-Fab					
13	Denso					
14	Toyota					
15	Monolith (US)			✔		Using SiC Foundry (X-Fab)

Table.1 FOM outline and device cost and sales price

			SiC			Si
	Summary of Performance FOMs	Units	A	B	C	D IGBT5
FOM	Specific Effective ON Resistance, RONxA @ Tj=Tjmax	mΩ·mm2	1168	670	644	2600
	Specific Intrinsic ON Resistance, RONxAA @ Tj=Tjmax	mΩ·mm2				
	Qg x RON @ Tj=Tjmax	nC·Ω				
	Ciss x RON @ Tj=Tjmax	pF·Ω				
	Crss x RON @ Tj=Tjmax	pF·Ω				
	Coss x RON @ Tj=Tjmax	pF·Ω				
	Turn-off Switching Energy, Eoff x RON @ Tj=Tjmax	mJ·mΩ				
	Turn-on Switching Energy, Eon x RON @ Tj=Tjmax	mJ·mΩ				
	Maximum Switching Frequency, fmax	kHz				
Cost & Price	Average Selling Price, ASP (Retailer)	$/unit				
	ASP per Ampere (@ 100℃)	$/A				
	ASPxRON	$·Ω				
	Estimated Manufacturing Die Cost	$/unit				
	Processed Wafer Cost (Estimated)	$/wafer	[illegible]	[illegible]	[illegible]	[illegible]

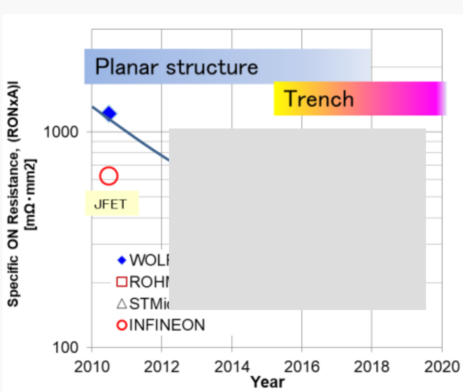

Fig. 3.4: Trend of on-resistance (RONxA) performance index (FOM) per area

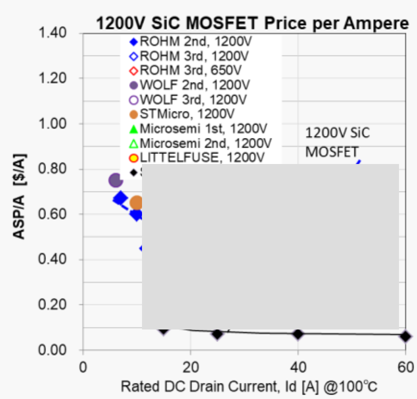

Fig. 4.3: Average selling price per ampere (ASP / A)

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※レポートデータ抜粋

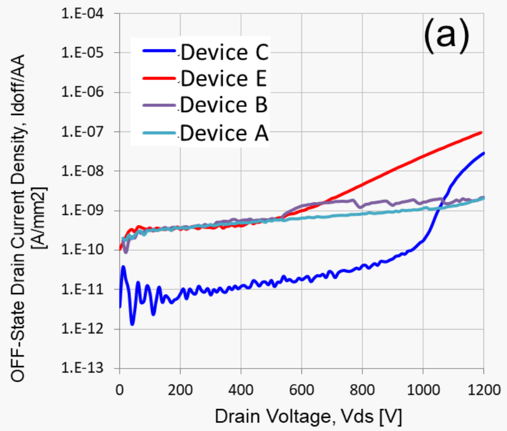

Fig. 5.14: Comparison of drain leakage current

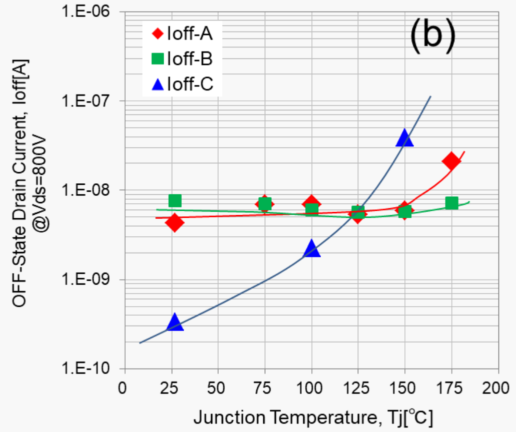

Fig.5.15: Drain current temperature dependence at off mode: Ioff (Vgs = 0 V and Vds = 800 V)

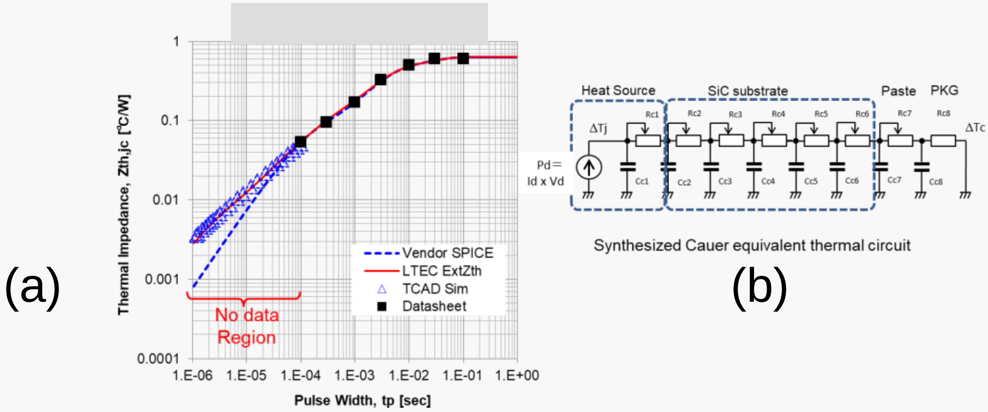

Fig.5.30: (a) Thermal impedance Zth vs. on-time pulse width (b) extracted equivalent heat circuit

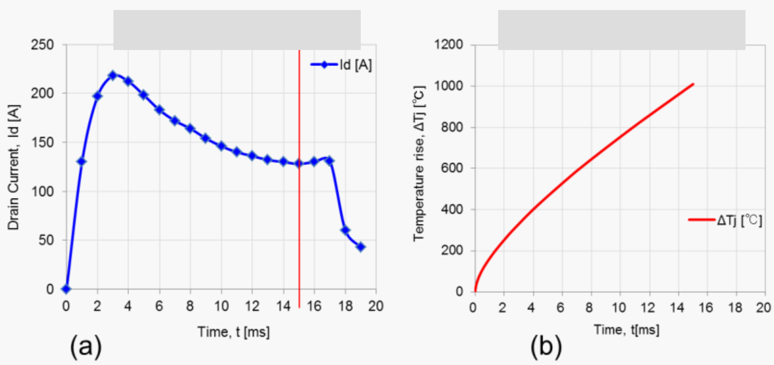

Table 3: Summary of the estimated device temperature ΔTj

		Datasheet Graph	Manufacturer Zth model	1D Model	Simulated
Pd	W	8.43×10^4			
t	μs	15			
Zth	℃/W	0.006※	0.003	0.0106	
ΔTj	℃	506	253	894	1033

※ Extrapolated from graph

Fig.5.31: (a) Shorted drain current waveform at Vds = 580 V and Vgs = 19 V (b) Die temperature at short circuit mod
Table 3. The data summary of the device temperature calculated from this analysis (yellow)

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