New Release

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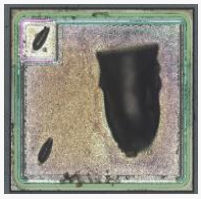
SiC MOSFET (400V): Infineon IMBG40R045M2H Overview, Structure, Process and electrical characteristics Analysis Reports

Package



SiC MOSFET Die

Background/Overview

As the computational requirements of artificial intelligence (AI) processors increase, server power supplies (PSUs) need to supply large amounts of power with high efficiency. In May 2024, Infineon announced a 400V SiC MOSFET using its 2nd-generation CoolSiC technology for AI power supplies(※).

This product is the first industrial SiC MOSFET in the 400V range, competing with GaN transistors, and future adoption trends are also attracting attention. This time, we will release a three-part report clarifying the product's features, such as structure, process, and electrical characteristics evaluation.

（※） https://www.infineon.com/dgdl/Infineon-400_V_CoolSiC_AI_server_deepdive-ProductPresentation-v02_01-EN.pdf?fileId=8ac78c8c8eeb092c018fb8955f4d1553

Product features

- Part：IMBG40R045M2H　Vdss= 400V,　43A,　44.9mΩ
- Released：May 2024
- Ultra-low conduction loss and switching loss compared to 650V SiC and Si MOSFETs
- Switching power supplies (for servers and AI), Energy storage, UPS, battery formation

Report Contents/results (See pages 2, 4, and 6 for the table of contents of each report)

(1) Overview analysis report: (13pages)

- Observation of package and die, cross-sectional observation of cell and die end parts.

(2) Structure analysis report: (77pages)

- SiC MOSFET planar and cross-sectional structure analysis, cell part (TEM) including the contents of (1).
- Infineon's unique asymmetric trench gate structure and reduced cell pitch achieved an intrinsic on-resistance RONxAA = 103mΩ mm2.
- The thickness and doping of the N-epi drift region are adjusted for 400V operation.

(3) Process and electrical characteristics analysis report: (43pages)

- Extraction of manufacturing process steps and observation and consideration of process features.
- Extraction of N-epi concentration profile.
- Consideration of electrical characteristics and device structure: Ultra-thin N-epi and RON components (Rch, Repi) and breakdown voltage correlation. Mainly, narrow margin of BVdss vs. rated drain voltage (Vdss = 400V).

Report price

Delivered one week after placement　　**Please contact us for report pricing.**

LTEC Corporation US Representative Office www.ltec-biz.com/en/
2310 Homestead Rd, C1 #231 Los Altos, CA 94024
Phone: +1-(650) 382-1181
Contact2@ltec.biz

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Release day： 2025.01.17

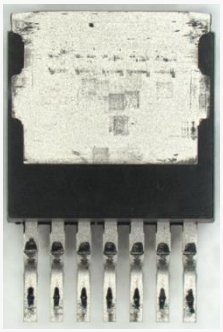
(1) Overview Analysis Report Table of Contents

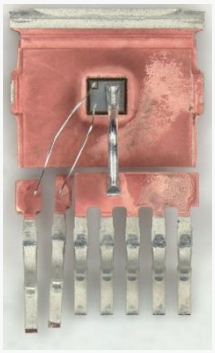
(1) Excerpt from the Overview analysis report

Table1-1: Device summary

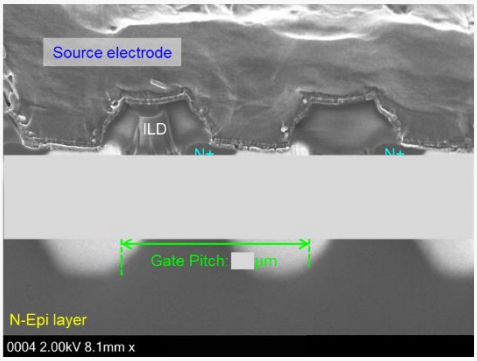
Device	SiC MOSFET (VDSS=400V, $R_{DS(ON)}$(Typ.) = 44.9mΩ (V_{GS} = 18V), I_D = 43A) RonAA = (mΩ·mm²)
Manufacturer	Infineon Technologies AG (Germany)
Product name	IMBG40R045M2H
Package type	TO-247-4L
Package marking	40R045M2 HAA2430
Die configuration	Transistor: SiC MOSFET x1
Die size	mm × mm = mm²
SiC MOSFET Die manufacturing process	SiC wafer, asymmetric trench gate, top metal source
Feature	• This product uses Gen2 process technology. • Comparing the structure of this product (400V product) with the Gen2 1200V product, the following was confirmed: · · It is estimated that this product is a customized version of the Gen2 product.
Application	• SMPS (Switch-Mode Power Supply) for Servers and AI • Solar PV inverters • Energy storage, UPS and battery formation • Class-D audio • Motor drives

Device summary



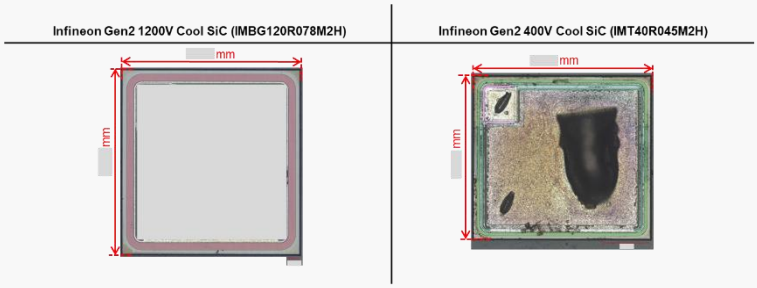


Package appearance



Cross-sectional SEM image of cell array

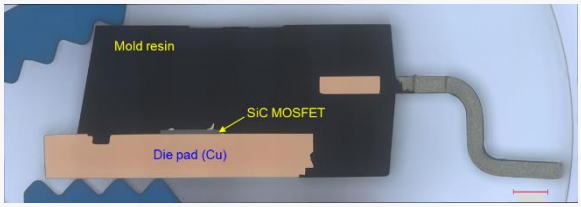
Cross-sectional SEM image of die outer periphery



Comparison with Gen2 1200V product (die size, die layout)

(2) Structural Analysis Report Table of Contents

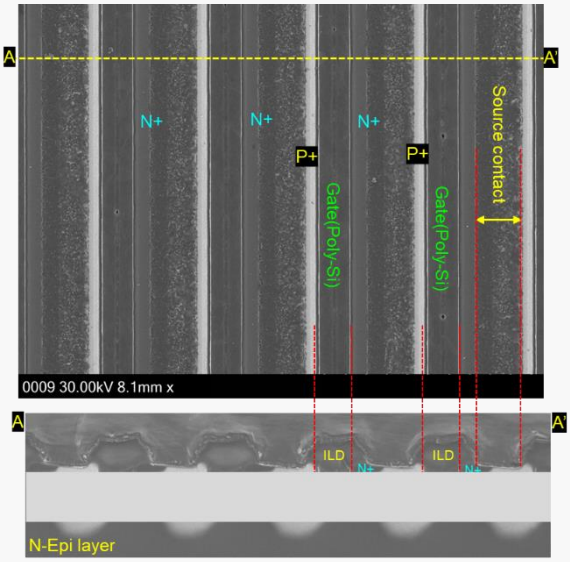
(2) Excerpt from the structural analysis report



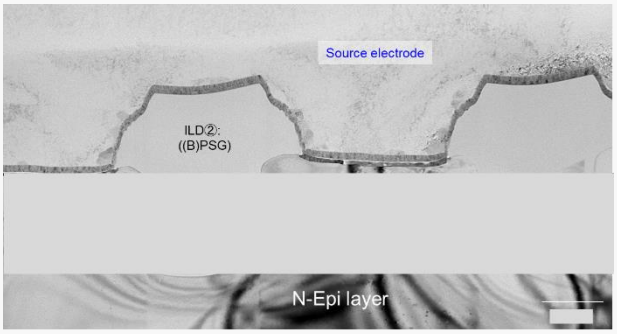
Package cross-sectional structure

Number	Measurement points		Length measurement	Materials
1	Mold resin			
2	Al wire			
2-1		Gate		
2-2		Source		
3	MOSFET			
3-1		Organic protective film		
3-2		Top metal		
3-3		Substrate		
3-4		Backside metal-1		
3-5		Backside metal-2		
4	Die attach			
5	Die pad			
5-1		Die pad		
5-2		Plating layer		

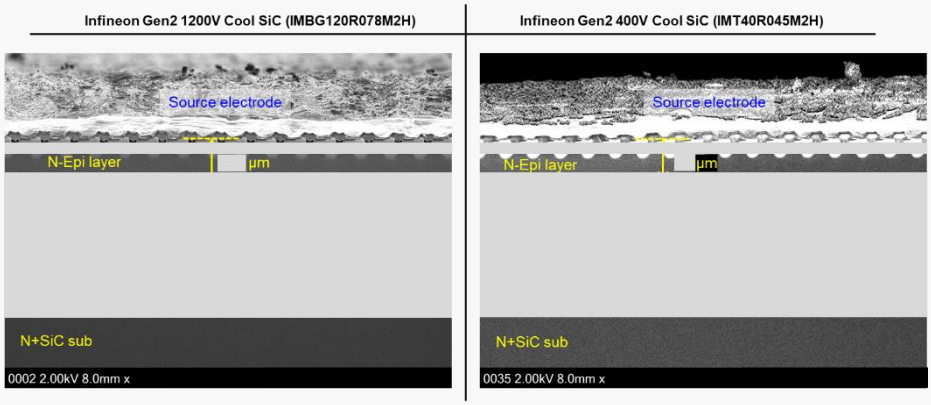
Package cross-sectional structure overview



Alignment of cell plane and cell cross-section



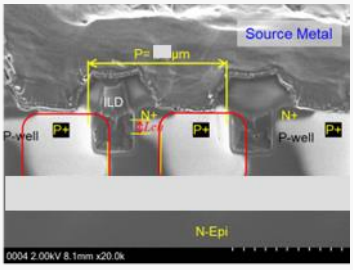
Cross-sectional TEM image of cell array



Comparison with Gen2 1200V product (Epi layer structure)

(3) Process and Electrical Characterization Report
Table of Contents

(3) Excerpt from process and electrical characterization report



400V Gen2 CoolSiC IMBG40R045M2H

Trench-to-DP alignment accuracy

The Pwell (Channel) width from the trench to the Deep

results in

$$\Delta W_{pw} \cong \sqrt{n\Delta^2 + \delta_{DP}^2 + \delta_{TR}^2} \cong \quad \mu m$$

Which, for a design value Wpwo=0.4um, means a

too

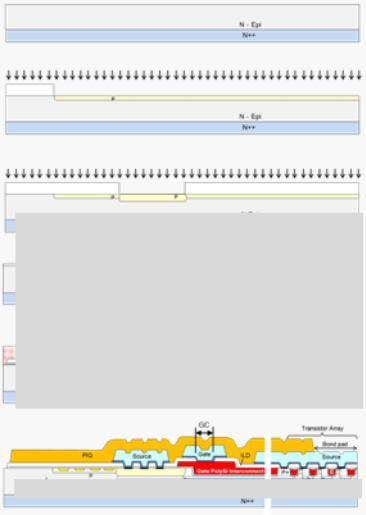
Possible Alignment Tree

AM ← JTE1

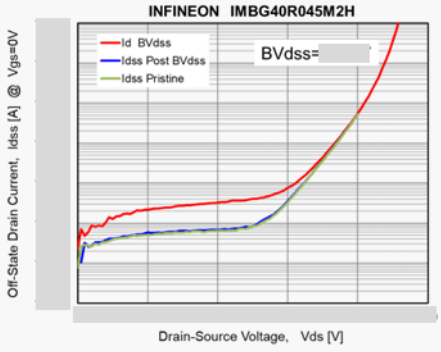
GC

MR

Infineon IMBG40R045M2H SiC MOSFET Process Sequence 1



SiC MOSFET Process sequence



Off-state breakdown voltage BVdss

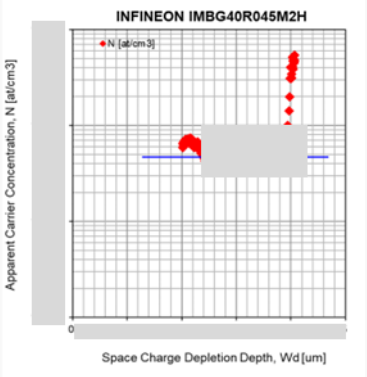


Fig.4-9-1 Carrier concentration profile

Carrier concentration profile in the depth direction

1-1. Characteristics comparison between SiC-MOSFETs and GaN FET

Table 1-1: SiC MOSFET Characteristic comparison

Manufacturer	Part no.	Application	Semi-conductor	Process	Production	Vdss [V]	RON [mΩ]	Die size [mm2]	Transistor cell pitch, P* [μm]	Intrinsic RONxA [mΩ·mm2]
ROHM	SCT4062KR	Industrial	SiC	Gen 4	2022	1200	62	5.7	2.0	219
INFINEON	IMBG120R078M2H	Industrial	SiC	Gen 2	2024	1200	78	4.0	5.6 **	180
INFINEON	IMBG40R045M2H	Industrial	SiC	Gen 2	2024	400	44.9			
INFINEON	IGT60R190D1S	Industrial	GaN			600	140			

LTEC Corporation US Representative Office www.ltec-biz.com/en/
2310 Homestead Rd, C1 #231 Los Altos, CA 94024
Phone: +1-(650) 382-1181
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