

SIMS study of a Semiconductor Opening Switch diode

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1 Pulsed power generators based on Semiconductor Opening Switch (SOS) diodes produce nanoseconds high-voltage pulses.

Applications in biophysics and biochemistry

Biological response of pulsed electric field exposure
 Atmospheric pressure air glow discharge
 Pulsed breakdown in water
 Surface & skin sterilization
 Spark surgery
 Plasma medicine
 Wound healing
 High power switching

Pulsed discharges in air
 Water & air purification
 Tumor therapy
 Biofuel generation
 Surface modification

2 The switching mechanism of the SOS diodes is well studied and explained according to modern theory. However, ...

SOS diode production not wide
 Just a few manufacturer worldwide
 Limited availability of SOS diodes

In literature, we found theoretical doping profile, no SIMS analysis result.

New information of the structure could bring additional knowledge.

3 Novelty: Analyze a SOS diode by SIMS over several hundreds μm

Our SOS diode specimen:

4 identical silicon dies connected in series and sandwiched between anode and cathode metals

Slice with mirror-like surface on which SIMS analyses are performed.

4 Raw profiles of boron & aluminium doping with matrix signal

Scan length: 1150 μm; step of 2 μm; 575 measuring points; Total duration ~1h30

5 Raw profile of phosphorus doping with matrix signal

Scan length: 1150 μm; step of 2 μm; 575 measuring points; Total duration ~1h45

Relative sensitivity factors (RSF) & detection limits (DL) determined on Si implanted standards

Element/matrix	¹¹ B/ ³⁰ Si ⁺	²⁷ Al/ ³⁰ Si ⁺	³¹ P/ ³⁰ Si ⁻
RSF // DL (at/cm ³)	1.8 x 10 ²¹ // 5.0 x 10 ¹⁵	4.5 x 10 ¹⁹ // 1.0 x 10 ¹⁴	3.5 x 10 ²¹ // 3.5 x 10 ¹⁶

6 Measured doping profiles of the 4 silicon dies connected in series

Sample surface state after tests and analyses

Theoretical doping profiles of a unique silicon die

Partial matching between measurement and theory

- Lowest [P] not reached (due to the DL at the time of analysis)
- Depth of the p-n junction difficult to determine (fundamental characteristics usually determined by measuring the breakdown voltage of the diode)
- High [P] not expected on the anode side
- High [B] with [Al] not expected on the cathode side

Conclusion Keeping in mind observations above, SIMS is a promising tool to analyze SOS diodes.

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