DSG
TECHNOLOGIES

Agenda

DSG Overview

DSG AXOM Tool

DSG Process Applications:

- Activation
- Silicide Formation
- a-Silicon Crystallization

Executive Team

DSG Overview

- Jeffrey Kowalski
- President/CEO of DSG Technologies:
  - 34 years Semiconductor Experience. Mostek.
  - President Silicon Valley Group (SVG) / ASML 1995-2004.
  - Founded DSG Technologies in 2004

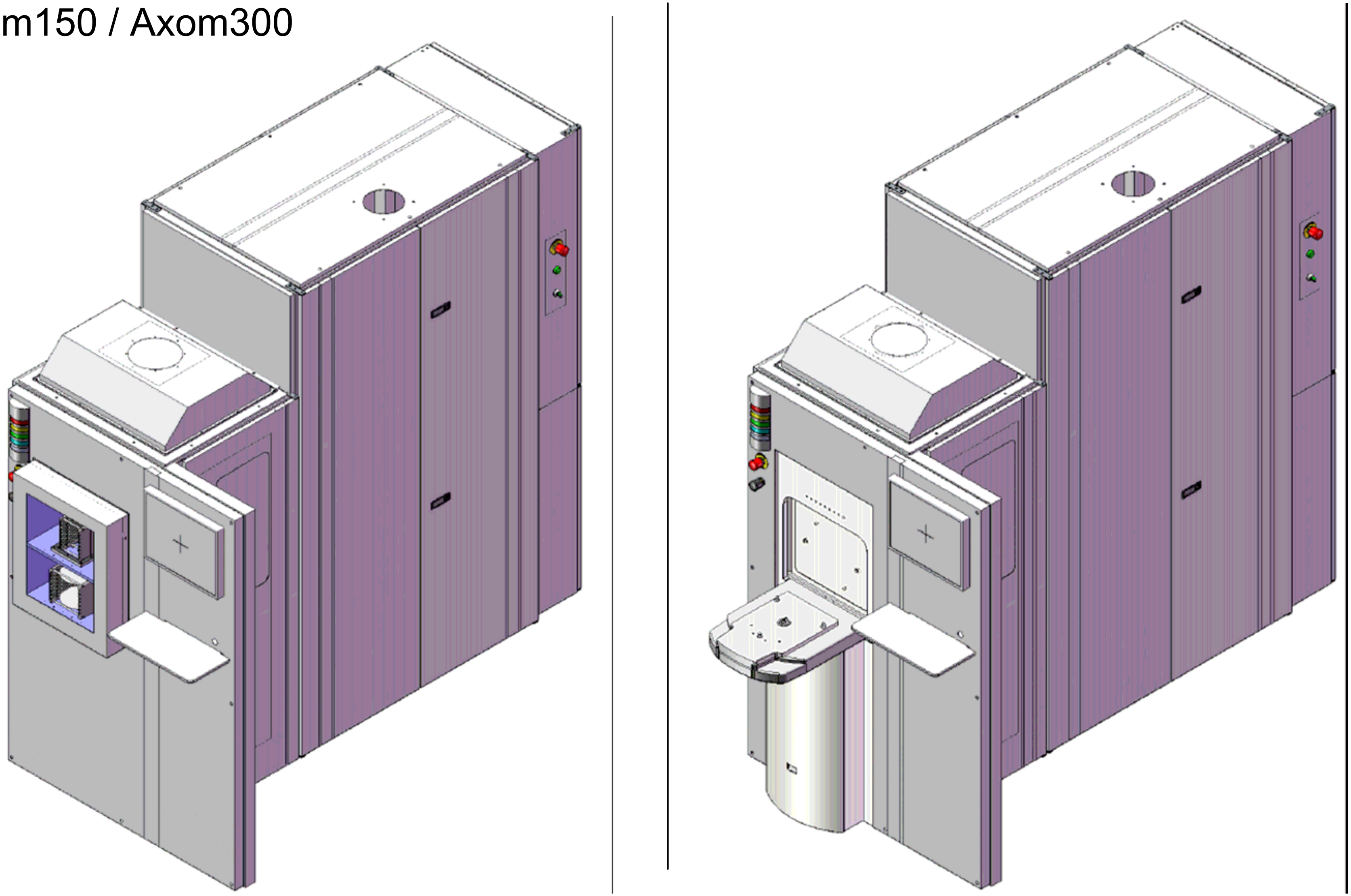
DSG Technologies

DSG Overview

- **Founded 2005: California Corporation**
- **Private Equity Funded**
- **Development / Demo Center in Morgan Hill, CA**
  - **Development Systems in Class 10,000 Clean Room**
  - **Microwave Modeling Capability for New Materials**
- **Currently Working in Development Programs with >20 Customers:**

Axom Tool Layout

Axom150 / Axom300



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Low Temperature Activation

- Si, SiC, Sapphire Substrates
- Low Thermal Budget < 500°C Activation
  - Boron : Arsenic : Phosphorus
- Throughput > 50 WPH (300mm)
- Low Dopant Diffusion
- Patented Microwave Technique
  - Low Leakage
  - Effective with Low Dosages

Background

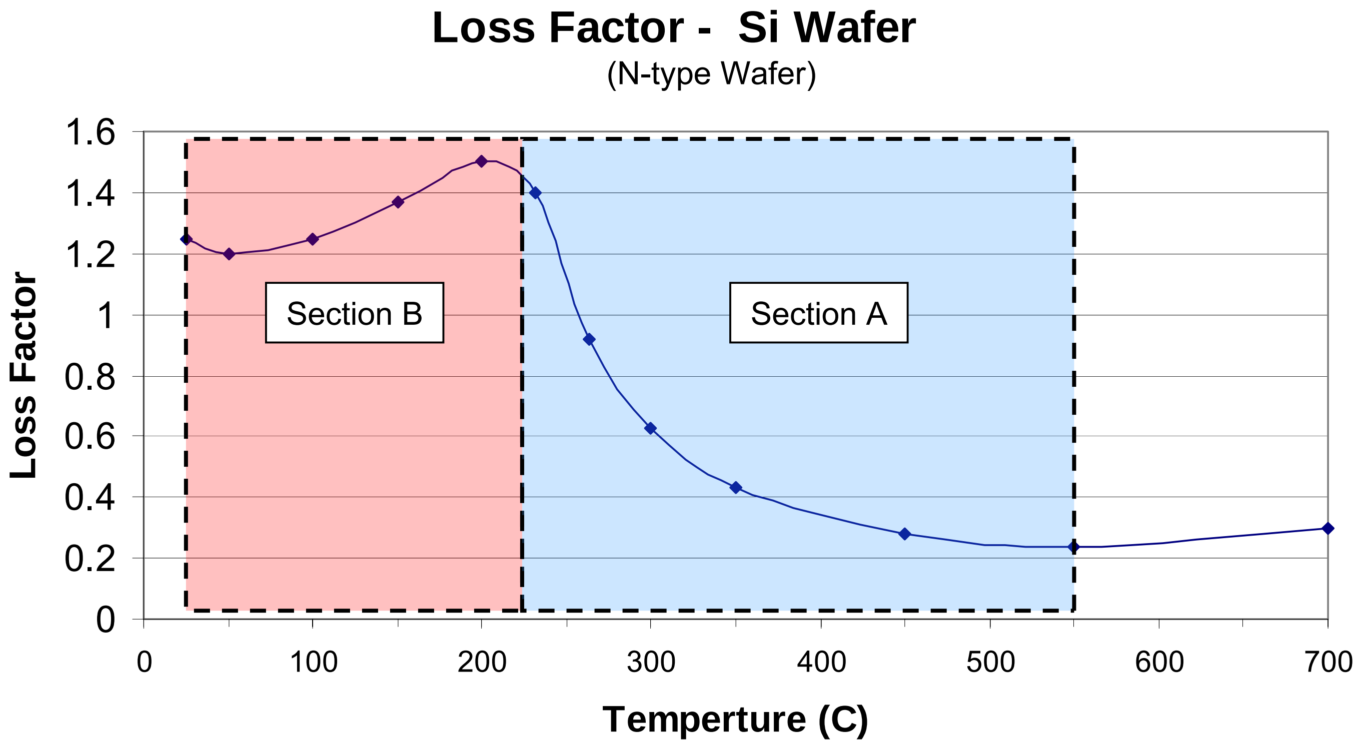
LTA

- **In semiconductor materials, electrons move freely in response to the MW electrical field and an electric current results. The flow of the electrons will heat the material through resistive heating. The higher the resistance of the semiconductor material the higher the temperature it will reach. The average MW power per unit volume is converted to heat.**

MW Efficiency

Axom 300

- Loss Factor represents the efficiency of microwave absorption in the wafer, as the loss factor decreases the efficiency of the microwave absorption decreases.



P-Type Activation : Spike vs MWA

PAI

Species : GE
Vacc : 15 KeV
Dose : 3e14 cm^{-2}

Main I/I

Species : BF2
Vacc : 1.5 KeV
Dose : 1.5e15 cm^{-2}

	Spike	MWA
Temperature	1050°C	490°C
Rs (Ohm/Sq.)	665	720
STD DEV (%)	6.3	6.1

P-Type Activation : Spike vs MWA

- Comparable Mobility and Carrier Concentration even at Shallow Junction Depth

Hall Carrier Evaluation

	Spike	**MWA**
Rs (Ohm/sq.)	**577**	**588**
Hall Coef(m^2/C)	**1.58**	**1.90**
Mobility($cm^2/V\cdot s$)	**27.4**	**25.3**
Carrier Conc(cm^{-2})	**3.95E+14**	**3.38E+14**

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Ge Epitaxy on Si

- Comparisons of Sheet Resistance on Ge Epitaxy Wafer Between RTA and Microwave.
- X-Ray Diffraction (XRD) Analysis

X-Ray Diffraction (XRD) Analysis

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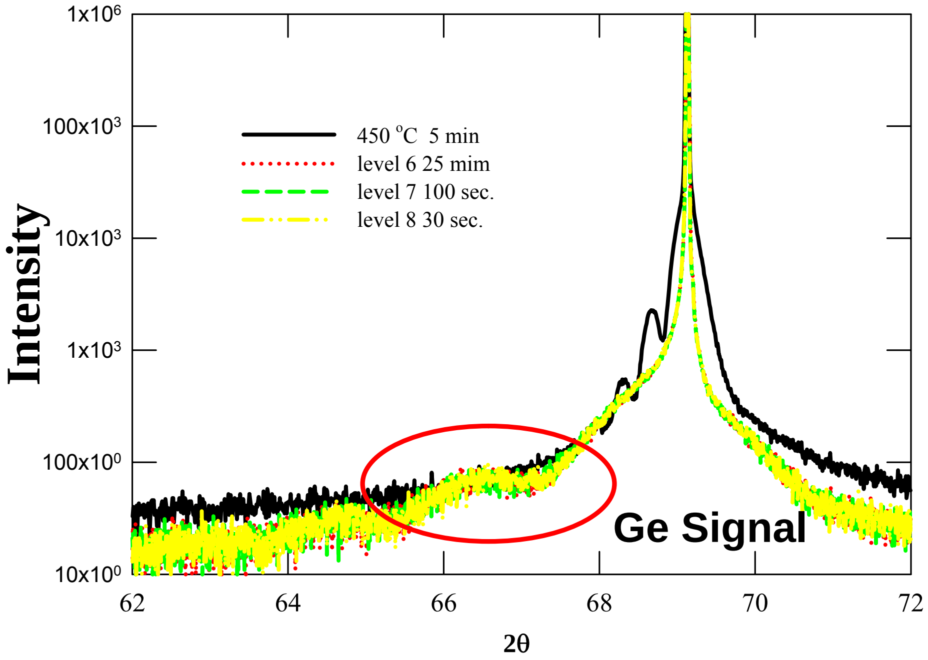
- RTA Will Degrade the Ge Crystal
- The Ge Signal Still Exits after Microwave Treatment



Sheet Resistance (Ohm/sq.)

Ge Epitaxy

	320° C 100 sec.	400° C 100 sec.	500° C 30 sec.	600° C 10 sec.
RTA	**No Reading**	**1.10E4**	**6.18E3**	**5.30E3**
Microwave	**4.3E2**	**2.1E3**	**8.63E2**	

- On N-type wafer, BF_2 15keV, 5E15 cm^{-2}
- N type wafer, resistively: 2~10 Ω-cm

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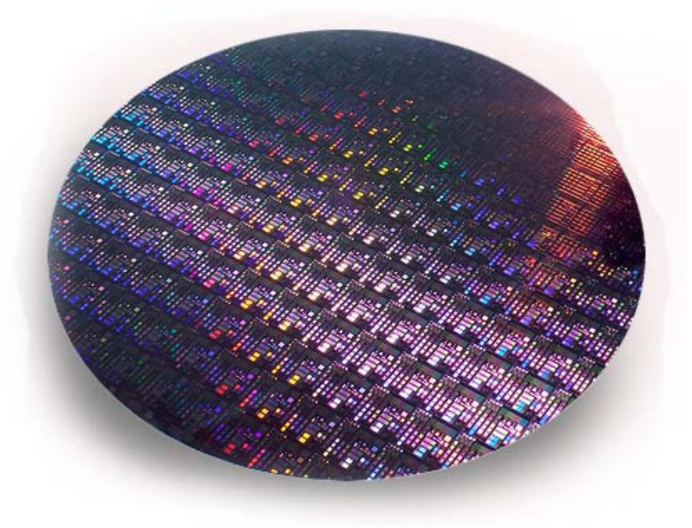
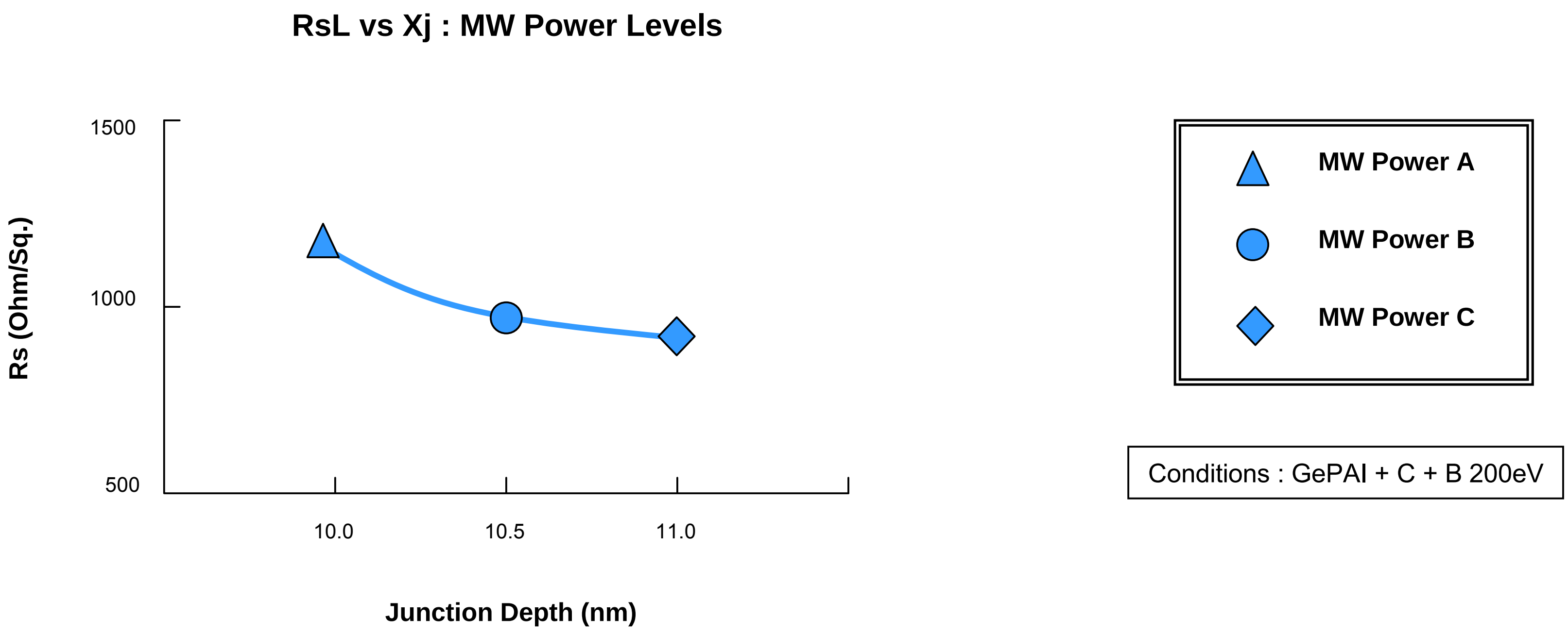
22nm
Devices

MW Applications



Activation: P-Type

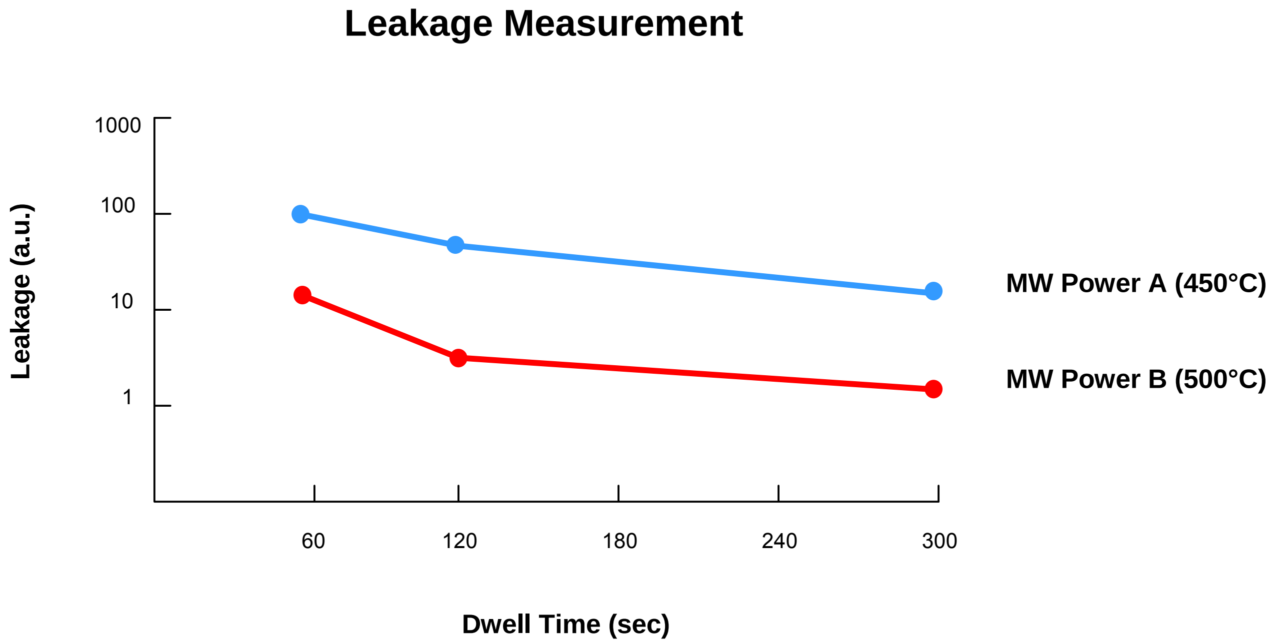
- Total MW Power – 1st Order Condition to Drive Absorption Efficiency
- Average Power per Unit Volume is Converted to Heat



Conditions : GePAI + C + B 200eV

N-Type Activation : Leakage

- Leakage Reduced with Longer Dwell Time or Increased MW Power



USJ Activation

USJ Activation with PAI: B 0.5keV, 5E14

PAI Implant	Rs (ohm/sq.) Avg.
5 keV, 1E15	810
10 keV, 1E15	750
15 keV, 1E15	760
20 keV, 1E15	755

Without PAI: Rs = 6150 ohm/sq.

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Nickel Silicide Formation

- Formation of NiSi 220°C
- Process time: 60 seconds
- Throughput >100 WPH (300mm)
- Reduced Leakage in Replacement RTP2

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a-Si Crystallization

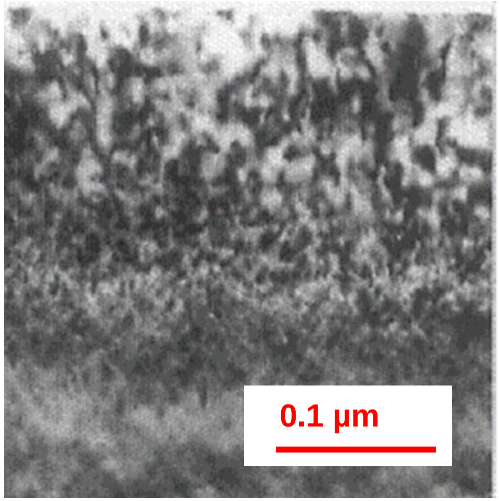
Damage Recovery

Metal Gate anneal w/ Al

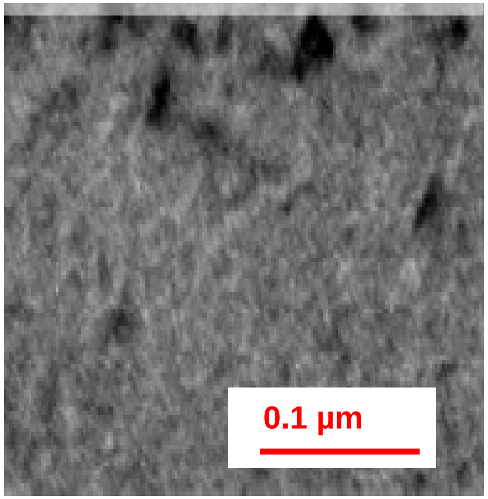
- **MSM Capacitor Formation**
- **Image Sensor Damage Recovery**
- **Integration: Metal Gate ZrO2 Crystallization < 250C**
- **Single Crystal Ge Activation**

Image Sensors – Damage Recovery

- DSG R&D Research Project for Next Generation Image Devices
- Recovery Levels equal to 1300°C RTP / Multiple Laser Steps
- Damage Recovery Improvement over Thermal Anneal



1300°C Standard Anneal
Si Implant 70 keV



600°C MW Anneal
Si Implant 70 keV