



Ion Implantation and Applications for Power Devices

Outline

Introduction

Silicon carbide doping challenges

Implant Species and Source Operation

High Temperature Implant for Implant Damage Control

Silicon Carbide Structure and Implant Solutions

High Energy Implant for SiC Trench MOSFET

Purion XEmax High Energy System

Summary

Axcelis at a Glance

Global leader in technology development and manufacturing of ion implant systems and services for the semiconductor industry for 45 years

Serving the ~\$2.7B ion implant systems market

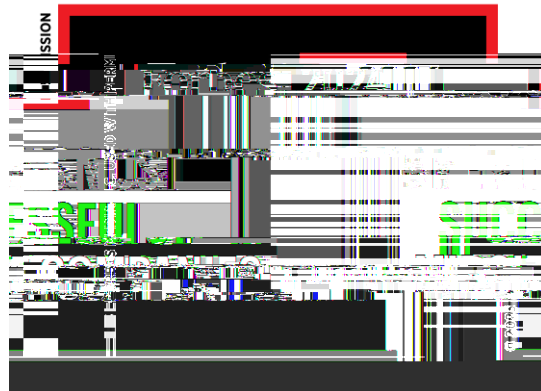
Based in Beverly, MA with headcount greater than 1700 worldwide

Global customer support infrastructure

Growing installed base of greater than 3000 tools

Strong IP portfolio

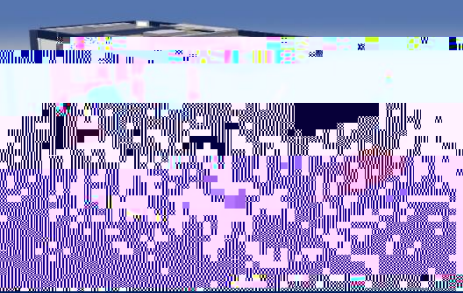

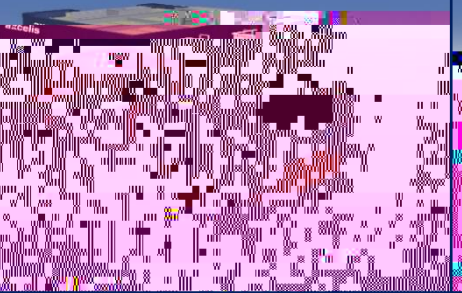
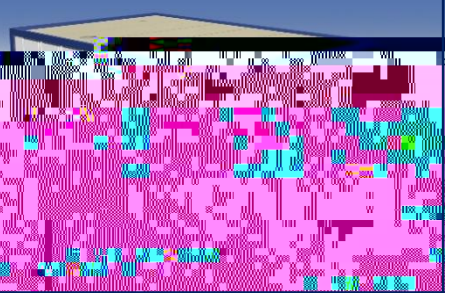
Supplier of record to leading semiconductor CAPEX spenders in all market segments including DRAM, NAND, Foundry, Logic, Power and Image Sensor



axcelis



Product Overview - Common Purion Platform

Application Space	High Current	Medium Energy/ High Current	Medium Energy/ Medium Current	High Energy
				
Base Products/Model	Purion H Purion Dragon	Purion H200	Purion M	Purion XE/EXE/VXE Purion XEmax
Power Series™		Purion H200 SiC	Purion M SiC	Purion XE/EXE SiC
Customer Markets	Adv DRAM/NAND & Logic Material Modification	Power Device Mature Technologies	Power Device RF Mature Technologies Adv DRAM/NAND	Power Device Image Sensor Mature Technologies Adv DRAM/NAND

Silicon Carbide Doping Challenges

Aluminium: P-type dopant

Solid source vaporizer like, All

Implant and Annealing Strategy

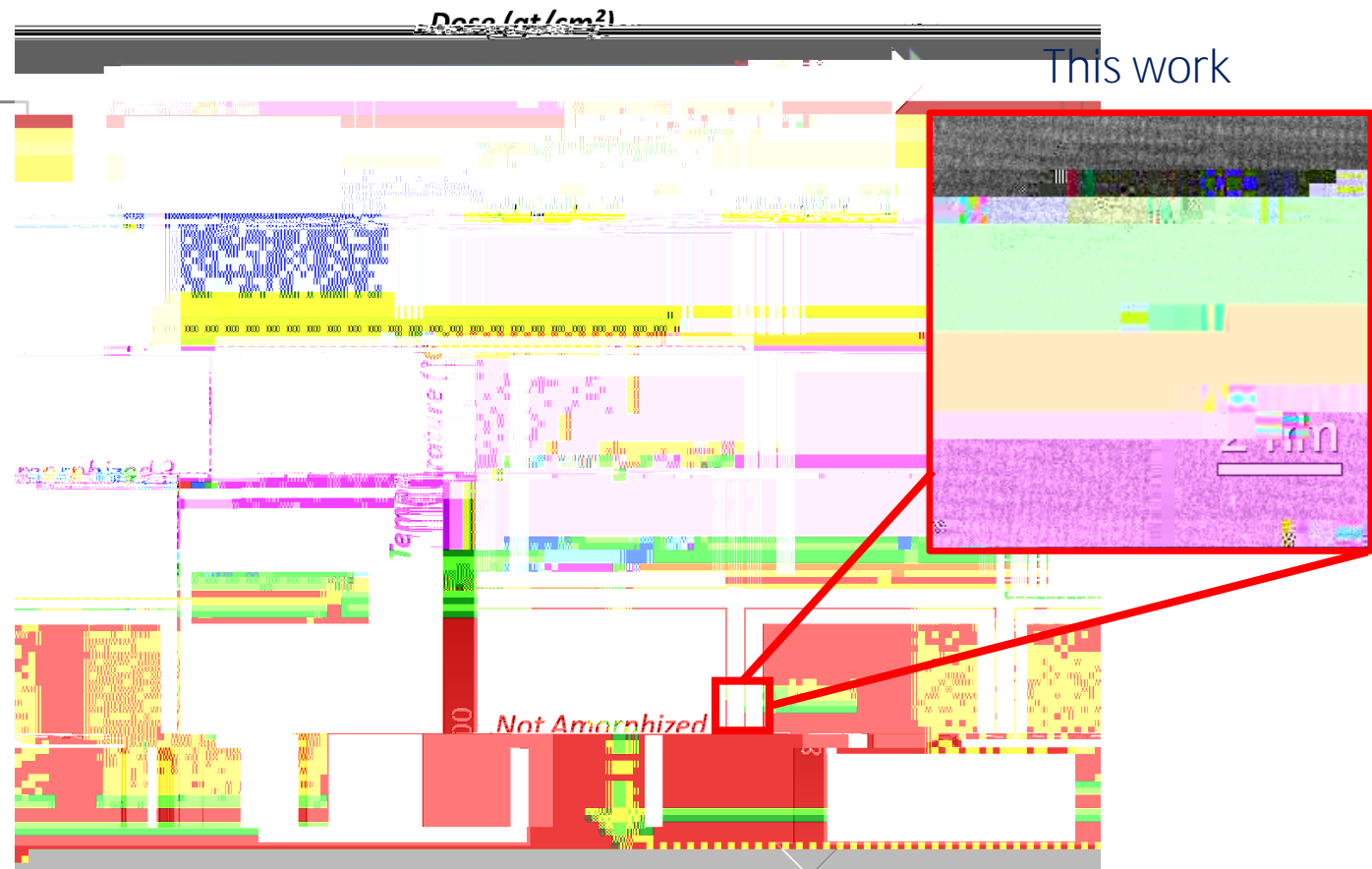


Advanced ion implantation
Control & Minimize defect level

Avoid capping layer process and to
reduce manufacturing costs

Laser annealing to combine
high temperature activation efficiency
with no high thermal budget-induced
extending defects

Hot Implant and Annealing Control to Implant Damages

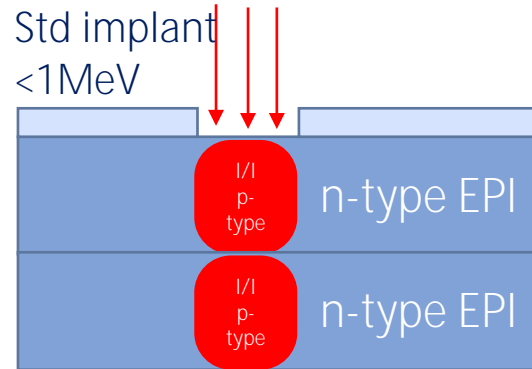


[1] Y. Negoro et al. (2004).

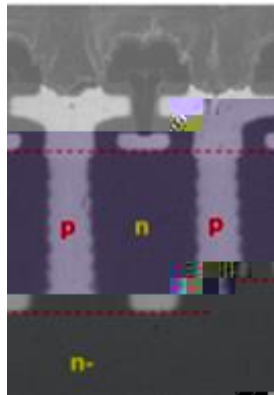
High Temperature Implant for SiC Implant Defect Control
"Warm" or Room Temperature Implants at Lower Lose for Productivity Consideration

Super Junction Formation and High Energy Implant

(Multi-step) n-EPI/p-type implant

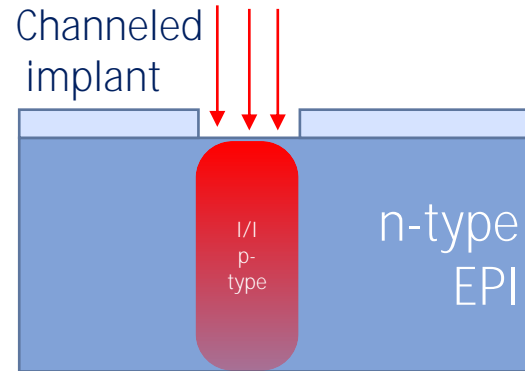


Process (Multi Epi/Implant Step):
 Each n-type EPI (literature 0.7-0.8um)
 Masking and opening at p-type pillar
 Compensating implant
 Repeat



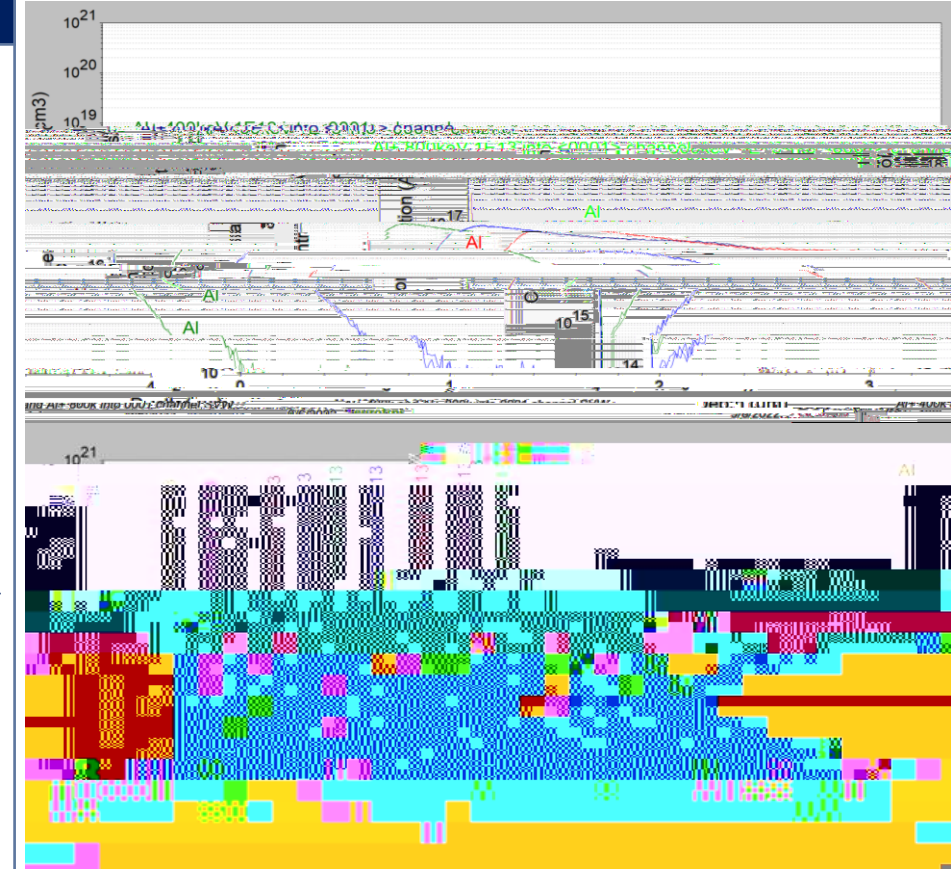
Kobayashi, Y. et al. (2019).
 (ISPSD) (pp. 31-34). IEEE.

n-type (EPI) + p-type implant



Process (Single Epi Step):
 n-type EPI (final thickness)
 Masking and opening at p-type pillar
 Multiple implants or channeling implants

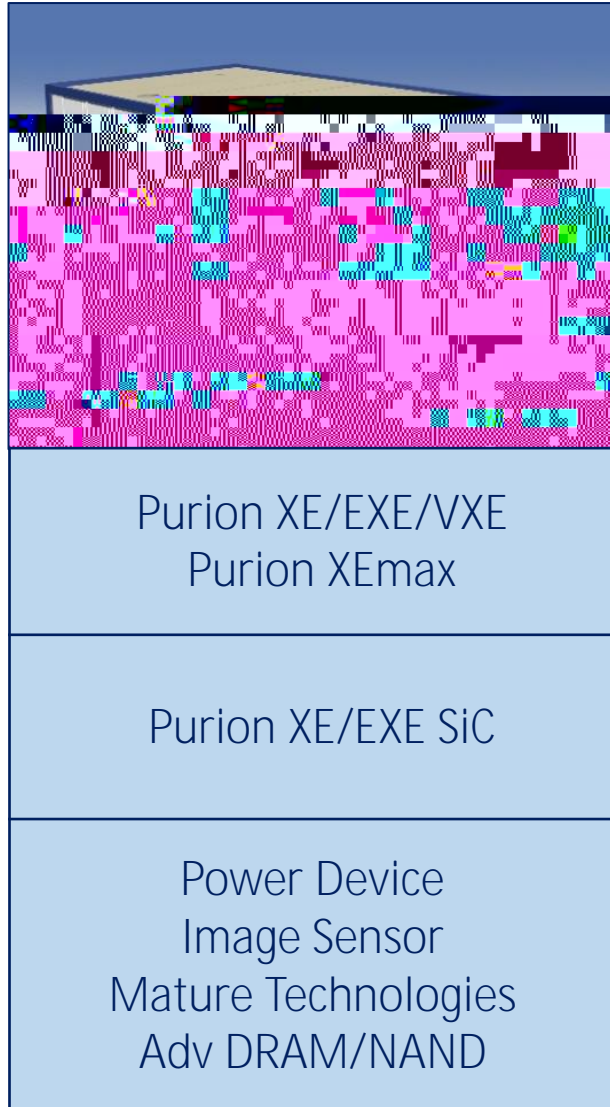
Channeling Implant Profiles



Enable deeper profiles with fewer and lower energy implants

Implant angle accuracy for channeling profile control

Axcelis High Energy Implant Systems



Linear acceleration (LINAC) technology

Market leader

High productivity

Reliable and cost effective

High temperature implant for SiC

Purion XE

Purion EXE

New developed systems:

Purion XEmax

— Ultra high energy system (15MeV)

— To satisfy implant roadmap requirement

Axcelis Offers Complete Set of High Energy Systems for IC Manufacturing

Purion XEmax High Energy System

Designed to achieve high energy implant capability

- Higher extraction current

- Longer source life

Booster module acceleration

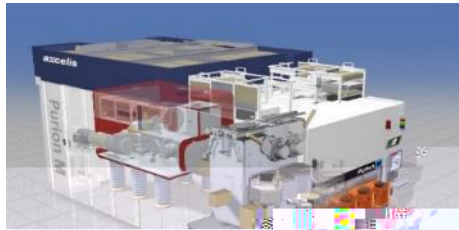
- Select higher charge state ion after booster

- Eliminate energetic contaminants generated from ion source

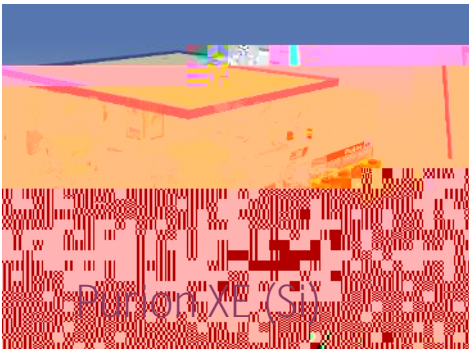
S bend corrector magnet

Axcelis Purion Power Series for SiC

Highest Productivity Solution for ALL Implants in SiC HVM

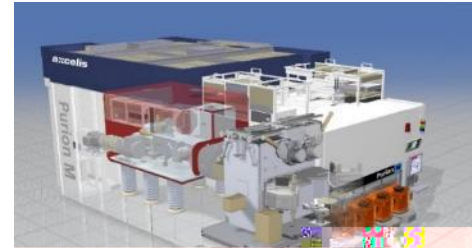


Purion M (Si)

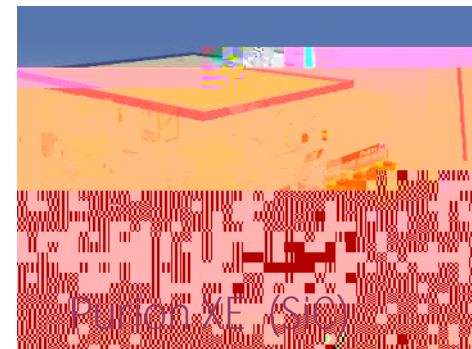


Purion H200 (Si)

Al+ Source
 150/200mm SiC
 Wafer Handling
 Heated Implant
 Capability (650°C)



Purion M (SiC)



Purion H200 (SiC)

Energy Range (keV)

Species	M	XE	H200
+	335	1200	200
++	670	2700	400
+++	1000	3500	--

Highest Productivity Tool Set for SiC Manufacturing

Axcelis makes critical R&D investments to fuel continued innovation that further differentiates our products

Axcelis tools provide a variety of competitive advantages across all customer segments

Axcelis provides SiC implantation solutions

- Medium energy with high current implant capability

- Provide high temperature implant capability with high productivity

- Provide high energy system for profile optimization/engineering

