Selkirk College
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Clean-Tech Ion Implantation for Next-Generation Power Electronics

High-Charge-State Nitrogen and Aluminum Implants on Silicon Carbide (SiC)

Selkirk Ion-source Research Centre (SIRC) and D-Pace

Funded by the Mitacs Accelerate Program

This Mitacs-funded project addresses a critical clean-technology challenge in **power electronics manufacturing**—enhancing the performance and sustainability of components used in **electric vehicles, solar farms, and wind energy systems**. By improving how dopants such as **nitrogen and aluminum** are implanted into **silicon carbide (SiC)**, the research directly supports **energy-efficient, long-life semiconductor devices** vital to the global green-energy transition. This initiative is consistent with the National Semiconductor Strategy which Canada's Semiconductor Council (CSC) submitted to the federal government in pre-budget consultations.

Innovation

Conventional ion implanters operate with singly charged ions (1^+), requiring costly, high-voltage accelerators for deeper SiC penetration. The SIRC team is developing a **Penning ion source** capable of producing **quintuply charged ions (N^{5+} and Al^{5+})**—a breakthrough that **multiplies implantation energy fivefold** within existing implanter systems. This eliminates the need for multi-megavolt infrastructure, dramatically **reducing equipment costs, power consumption, and environmental footprint** in semiconductor fabrication.

Commercialization Potential

The technology demonstrates clear **commercial scalability**: retrofitting existing implanters with a high-charge-state ion source offers manufacturers a **low-cost pathway to high-performance SiC processing**. The innovation could be **licensed or co-developed** with equipment OEMs, enabling Canada's clean-tech sector to strengthen domestic capabilities in sustainable microelectronics and advanced materials manufacturing.

Next Steps

Ongoing work will benchmark ion beam stability, charge-state yield, and throughput for industrial integration, advancing this **Penning-based clean-ion implantation system** toward **commercial demonstration** and **technology-readiness validation**.