INNOVATION PARTNERSHIPS
UNIVERSITY OF MICHIGAN

# Uniform and Controllable Si Doping of Aluminum Nitride

### TECHNOLOGY NUMBER: 2024-013

### OVERVIEW

Controlled Si doping in aluminum nitride using hybrid epitaxy methods

- Enhances Si incorporation control in AlN, optimizing conductivity and electron concentration
- Improves high power electronics, optoelectronics, and high-frequency devices operating under harsh conditions

### BACKGROUND

Aluminum nitride (AlN) is increasingly valued for its excellent electronic properties, including a wide bandgap and high thermal conductivity, making it ideal for next-generation high-power electronics. Historically, attempts to dope AlN with silicon (Si) have faced challenges; methods like MOCVD and ion implantation have fallen short in controlling the Si concentration and maintaining uniform doping. The MOCVD technique is limited to Si incorporation levels below approximately 10^18 cm^-3, and ion implantation struggles with uniformity and maintaining electron mobility at higher concentrations. These limitations hinder the development of devices required to perform efficiently in high-frequency and harsh environments. Therefore, there's a critical need for a method that facilitates uniform and high-level Si doping in AlN, effectively advancing its application in electronics requiring high thermal stability and conductivity.

### INNOVATION

Researchers at the University of Michigan have developed a hybrid growth technique using plasma-assisted molecular beam epitaxy (PAMBE) to achieve uniform and controllable Si doping in N-polar AlN. By combining high-temperature and low-temperature growth techniques utilizing Ga as a surfactant, the method dramatically enhances the Si doping concentration—up to 2×10^20 cm^-3—while achieving an electron concentration of 1×10^19 cm^-3 at room temperature. This approach not only allows for fine-tuning of Si levels but also maintains excellent surface morphology and electron mobility. The innovation holds substantial potential for use in high-frequency electronic devices, power electronics, and optoelectronic applications that demand high-performance materials capable of operating under elevated thermal and environmental stresses.

### ADDITIONAL INFORMATION

**REFERENCES**

**Technology ID**
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**Category**
Hardware
Engineering & Physical Sciences
Semiconductor, MEMS, and Electronics

**Inventor**
Elaheh Ahmadi
Md Irfan Khan

**Further information**
Joohee Kim
jooheek@umich.edu

View online

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