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Iridium Oxide Schottky Contacts for High Temperature Aluminum Nitride-Based Devices

Researchers at Stanford University have developed Schottky contacts for aluminum nitride-based microelectronic devices. The contacts enable reliable device operation at up to 600 ºC, opening up opportunities for high temperature microelectronic performance.

Microelectronics capable of operating reliably at high temperature are necessary to provide sensing, readout, and telecommunications for applications in the space, aerospace, defense, automotive, and oil and gas sectors. Typical microelectronics produced for commercial, industrial, and military grade electronics, can often only perform reliably at temperatures up to 125 ºC. Above these temperatures, semiconductors fail to meet critical parameters and degradation can cause permanent failure. Aluminum nitride (AlN)-based high electron mobility transistors (HEMTs) that leverage the two-dimensional electron gas (2DEG) have shown promise for high temperature operations. However, the reliability is often limited by the degradation of accompanying metallization and passivation layers.

This technology provides a Schottky gate material as a passivation layer on AlN that can enable reliable high-temperature operation of AlN-based HEMTs. By oxidizing iridium on the AlN surface, devices fabricated with the material have demonstrated increased stability at high temperatures. Specifically, well-known degradation mechanisms in AlN-based devices, such as metal diffusion or electromigration during electrical characterization, are absent even at temperatures up to 600 ºC. Thus, the material offers promise in application to a variety of AlN-based devices where high temperature performance is essential.

Stage of Development: Proof of Concept

Applications

- Supercritical CO2 well leak detection in carbon capture and storage processes
- Industrial under-the-hood automotive and aircraft engine applications
- Uncooled downhole sensor readout for processes in the oil and gas industry
- Gas turbines
- Hypersonic structures
- Aerospace missions such as to the surface of Venus (surface temperature 465 ºC)

Advantages

- Free from deleterious strain relaxation effects at high temperature that have been demonstrated to lower the 2DEG density and adversely affect device performance in AlGaN based devices
- Offers higher electron mobilities so they are better for high frequency, high temperature applications compared to silicon carbide-based devices

Patents

- Published Application: WO2023239942
- Published Application: 20260123000

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