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Aluminum nitride (AlN) Power Devices

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Background

Wurtzite AlN has the largest bandgap (6.2 eV) among the wide bandgap semiconductor family including SiC (3.3 eV), GaN (3.4 eV), β-Ga_2O_3 (4.8 eV) and diamond (5.5 eV), which are attractive for various optoelectronic and electronic applications. However, due to the challenges in material growth and device fabrication, very limited work has been reported on AlN electronics. Currently, AlN primarily serves as substrates or templates on which optoelectronic devices are grown. However, for power electronics, AlN devices have the potential to outperform current GaN devices due to AlN's larger critical electric field (12 MV/cm) and thermal conductivity (340 W/mK). Therefore, there is a need to develop synthetic methodologies capable of producing high quality AlN crystals.

Invention Description

Recently, high quality AlN epilayers were achieved on sapphire substrates. Researchers at ASU have utilized this technique and created a 1-kV-class AlN Schottky barrier diodes. The device consists of a thin n-AlN epilayer as the device active region and thick resistive AlN underlayer as the insulator. At room temperature, the devices show outstanding performances with a low turn-on voltage of 1.2 V, a high on/off ratio of ~10^5, a low ideality factor of 5.5, and a low reverse leakage current below 1 nA. This work presents a cost-effective route to high performance AlN based Schottky barrier diodes for high power, high voltage and high temperature applications.

Potential Applications

- Optoelectronics
- Electronics

Benefits and Advantages

- Band Gap- The 6.2 eV band gap is significantly larger than the primary competitor GaN.
- Production- Uses conventional manufacturing techniques.

Professor Zhao's Website

Original Document