Aluminum Nitride based Semiconductor Devices
Technology #15343

Applications

This technology improves semiconductor structures, such as diodes and resistors, usually found in power transistors integrated in systems that rely on highly efficient converters. Applications for this technology involve cellphone amplifiers, satellite transition receivers, and high-efficiency electricity converters.

Problem Addressed

Current methods to fabricate III-V materials on Silicon (Si) substrate require a graded buffer layer, which adds to the processing requirements as well as introduces a potentially high concentration of threading dislocations. Additionally, the relatively low thermal conductivity and critical electric field of GaN limit the heat dissipation and breakdown voltage of GaN-based devices. This technology proposes the use of Aluminum Nitride (AlN) based devices due to its high critical electric field and high thermal conductivity relative to GaN. This allows for the creation of transistors that are capable of exhibiting higher breakdown voltages and lower on-resistances than transistors based on other semiconductor materials.

Technology

The invention is an AlN-based transistor device where carriers are confined using the polar nature of AlN. The polarization-induced electric field allows the conduction band to change in size, thus allowing the intermediate semiconductor region to be very thin. The thinness of the semiconductor layer causes carriers to accumulate within the region, and consequently creates electron gas within the device - producing an AlN-based field effect transistor. AlN-based devices reduce the thickness of conduction band gaps and lead to larger current densities compared to GaN-based devices. Several types of device structures utilizing AlN have been demonstrated with graded materials compositions, including DHFET (double-heterojunction field effect transistor) and POLFET (polarization-doped FET) devices. The graded composition prevents lattice mismatch within the different layers of the device. The graded POLFET devices exhibit a low threading dislocation density as well as a high current density.

Advantages

- High thermal conductivity
- High breakdown voltage
- Low threading dislocation density
- High current density

Categories For This Invention:

Electronics & Circuits
Electronic Components
Power Transistors

Intellectual Property:
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