Method for N-Type Doping AlxGa2-xO3 with Ion Implantation and Method for Forming Ohmic Contact on AlxGa2-xO3

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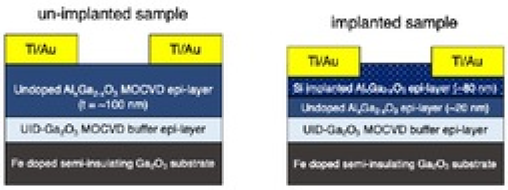

OVERVIEW

Doping of Aluminum-alloyed gallium oxide (AlxGa2-xO3) to form ohmic contact

- Placement of a titanium and gold stack as electrodes to create ohmic resistance
- Withstands high electric fields without suffering catastrophic failure

BACKGROUND

Next-generation power electronics operate at elevated voltages and frequencies, so they require materials that can withstand high electric fields to maximize efficiency and performance. It is also critical to be able to achieve good quality ohmic contacts with these materials to form a junction that provides current conduction from metal to semiconductor and vice versa. This goal is commonly achieved using wide bandgap materials such as gallium nitride (GaN) and gallium oxide (Ga2O3). Aluminum-alloyed gallium oxide (AlxGa2-xO3) is an attractive alternative to these wide bandgap materials because it has an even wider bandgap and hence, higher breakdown field. However, similar approaches of ion-implantation doping and ohmic contact formation for AlxGa2-xO3 have not yet been realized. The demand for high-power applications such as electric vehicles, renewable energy systems, and grid infrastructure highlights the need for improved methods for forming Ohmic contact on AlxGa2-xO3.

INNOVATION

Researchers have devised a method for doping Aluminum-alloyed gallium oxide (AlxGa2-xO3) to form ohmic contact with contact resistance. The method for doping Al-alloyed gallium oxide (AlxGa2-xO3) achieves n-type conductivity by introducing donor impurities into the material. Ohmic contact formation requires implantation, or doping, AlxGa2-xO3 through a reactive-ion etch before electrode deposition to ensure that the electrodes are in contact with the heavily

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doped region. Then, a titanium and gold (Ti/Au) metal stack is deposited as electrodes, following which post-metallization rapid thermal annealing is completed to achieve an ohmic contact. Those materials which are produced can withstand and dissipate high electric fields without suffering catastrophic failure have excellent insulation properties, minimal leakage current, and reduced dielectric losses. This platform technology opens the door to optimizing electrical and optoelectrical properties for next-generation power electronics based on wide-bandgap AlxGa2-xO3. This technology will enable power electronics and high-voltage applications.