Auburn University

Innovation Advancement & Commercialization

Low Temperature Impurity Doping of Silicon Carbide

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Reference: Low Temperature Impurity Doping

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Reference

Atabaev, et al. "Influence of Defects on Low Temperature Diffusion of Boron in SiC." *Materials Sciences and Applications*, 2011, 2 (9), 1205-1211. (Link)

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Overview

Auburn University is seeking licensees for a new method of low temperature silicon carbide doping. Impurity doping is used to control the electrical properties of semiconductors used in semiconductor junctions such as diodes, transistors, and other assorted uses. The new method allows impurity doping at temperature levels between 1150-1400°C by creating vacancies to allow for easier impurity diffusion. This method also allows for interface states passivation at the silicon carbide/silicon dioxide interface in the fabrication of MOSFET.

Advantages

- Allows for low temperature diffusion procedure with greater control over doping process
- Prevents roughness of the silicon carbide surface
- Creates fewer surface defects
- Produces better device performance and higher yield
- Allows for use of phosphorus in interface states passivation for SiC MOSFET.

Description

Conventional methods of doping silicon carbide include ion implementation, proximity annealing, in-situ doping, and use of spin-on dopant glass compounds. However the high temperatures needed in these techniques also can cause surface decomposition in the silicon carbide. This causes surface roughness and generates surface defects on the silicon carbide, which can have a negative impact on device performance.

Auburn's novel method for low temperature impurity doping creates vacancies to allow for easier impurity diffusion. In order to create these vacancies, an exothermic chemical reaction is used to offset the energy required for vacancy creation. By heating the silicon carbide in the presence of oxygen or any other element that draws out silicon or carbon, a compound like silicon dioxide is formed leaving silicon or carbon vacancies in the crystal structure. To accomplish this, a ceramic layer containing the impurity and the element that brings out the vacancies is deposited on the silicon carbide. The sample is then heated at a low temperature to create vacancies and then heated at the higher temperature to diffuse the impurity into the silicon carbide. These vacancies then assist in the diffusion of impurities into the silicon carbide which allows the process to take place at a lower temperature while still achieving a satisfactory diffusion rate.

This lower temperature doping process therefore prevents the surfaces roughness created by higher temperature processes and allows for more control over the doping process. This novel method can also be used for passivation of interface states at the silicon carbide-silicon dioxide interface to improve channel carrier mobility in silicon carbide metal-oxide-semiconductor (MOS)-based devices.

Status

- Low temperature diffusion of phosphorous in bulk SiC crystals has been demonstrated

Licensing Opportunities

- Issued US Patent: 7,999,268
- This patent is available for immediate non-exclusive licensing through Auburn's customizable "Ready to Sign" licensing program.
- Similar patents are available in the Electronics field.