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Novel Approach for n-Type Doping of HVPE Gallium Nitride with Germanium

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Abstract

We present a novel method for germanium doping of gallium nitride by in-situ chlorination of solid germanium during the hydride vapour phase epitaxy (HVPE) process. For this study, a customised vertical HVPE reactor with hanging substrate configuration, specially designed for investigations on different dopant methods was used. Solid germanium pieces were placed in the doping line with a hydrogen chloride flow directed over them. We deduce a chlorination reaction taking place at 800 °C, which leads to germanium chloroform ($GeHCl_3$) or germanium tetrachloride ($GeCl_4$). The reactor shows a germanium rich residue after in-situ chlorination experiments, which can be removed by hydrogen chloride etching. All gallium nitride crystals exhibit n-type conductivity, which shows the validity of the in-situ chlorination of germanium for doping. A complex doping profile is found for each crystal, which was assigned to a combination of localised supply of the dopant and sample rotation during growth and switch-off effects of the HVPE reactor.

Keywords: A3.Hydride Vapor Phase Epitaxy, A1.Doping, A2.Single Crystal Growth, B1.Gallium Compounds, B1.Nitrides, B2.Semiconducting III-V materials

1. Introduction

Gallium nitride (GaN), as a representative of wide band-gap semiconducting materials, can be used for numerous applications like transistors, light emitting diodes, laser diodes [1], sensory applications like terahertz detectors [2] or bio sensors, which use plasmonic properties of highly doped GaN [3, 4]. Single crystalline GaN is typically grown by heteroepitaxial approaches due to the lack

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