Growth of Cubic GaN on 3C-SiC/Si(001) Using Plasma-Assisted Molecular Beam Epitaxy

Background and Motivation

Cubic gallium nitride (GaN) is a promising material for high-frequency and optoelectronic devices due to its superior electronic properties and reduced polarization effects compared to its hexagonal counterpart. However, growing high-quality cubic GaN is challenging due to the lack of a native substrate and the high density of defects arising from lattice mismatch and thermal expansion differences with available substrates.

This study focuses on the growth of cubic GaN on 3C-SiC/Si(001). Since 3C-SiC is only available on silicon substrates, achieving high-quality 3C-SiC on Si(001) is itself a significant challenge. Improving the growth process and optimizing interface engineering can enhance the structural and electronic properties of cubic GaN films.

Objective

The primary goal of this project is to develop a process for growing high-quality cubic GaN on 3C-SiC/Si(001). The key objectives are:

1. **Controlling the Growth Conditions of ScN**: Optimize the interface and ensure the (001) orientation required for the growth of cubic nitride.
2. **Optimizing the Growth of Cubic GaN**: Develop and refine growth conditions for cubic GaN on 3C-SiC(001) using ScN as an intermediate layer to achieve high-quality cubic nitride films.

Methodology

The project will involve plasma-assisted molecular beam epitaxy (MBE) for material growth and advanced characterization techniques for structural and morphological analysis. Key tasks include:

1. **Surface Preparation:** Optimize protocols for preparing 3C-SiC to ensure a clean and well-ordered surface for subsequent growth steps.
2. **Intermediate Layer Optimization:** Investigate and optimize growth parameters to achieve a high-quality buffer layer with minimal defects and controlled orientation.
3. **Cubic GaN Growth and Characterization:** Grow cubic GaN on the prepared structure and assess its crystal quality using atomic force microscopy (AFM), high-resolution transmission electron microscopy (HR-TEM), and high-resolution X-ray diffraction (HRXRD).

Expected Outcomes

- Demonstration of cubic GaN growth on 3C-SiC/Si(001) with improved crystal quality.
- Detailed analysis of the influence of interface engineering on defect reduction and film quality.

Skills and Requirements

- Background in semiconductor physics, materials science, or related fields.
- Experience or interest in molecular beam epitaxy and material characterization techniques.
- Strong motivation to tackle scientific challenges in epitaxial growth.

Opportunities and Benefits

- Modern labs with a wide range of experimental techniques
- Supportive environment with experts for various scientific sub-fields
- International and culturally diverse community
- Location in the heart of Berlin with excellent public transport connections
- Subsidized travel ticket

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For further details or clarification, please feel free to contact us. Lab tours are also available for interested applicants.