

Thematic Session: Nanomaterials

Keywords: Nanowires, hexagonal Ge, nanostructures

Disciplinary fields involved: Material Science

Sustainable Development Goals* eventually involved in your research: Industry, Innovation, and Infrastructure

Hexagonal Ge on self-assisted GaAs Nanowires in MBE

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Abstract

Hexagonal Ge is predicted to have novel electronic and optoelectronic properties therefore attracting great interest in the field of optoelectronics [1]. So far, hexagonal (Si)Ge with direct bandgap and wavelength tunability have been fabricated using nanowires with gold as a catalyst [2]. However, it is not compatible with the current CMOS technology [3].

In our work, hexagonal Ge has been grown on the facets of self-assisted GaAs nanowires by MBE using VLS mechanism [4]. An extended pure wurtzite segment was maintained by tuning the V/III ratio to appropriate values [5]. Following the growth of the GaAs core, a Ge shell has been grown with a long hexagonal segment. The crystal structure of the nanowires has been characterized with high-resolution scanning transmission electron microscopy (STEM) and dark field transmission electron microscope (TEM). The Ge surface chemistry was studied by X-ray photoelectron spectroscopy (XPS), and photoluminescence spectroscopy (PL) was performed to investigate the optical properties of the hexagonal Ge phase. The results have shown that the growth mechanism induce a strong As doping in hexagonal Ge, which can be controlled in a certain extent. Furthermore, the quantum confinement can be achieved in hexagonal Ge, leading to a blueshift of the emission.

References:

- [1] Barth, S. (2021). Metastable Group IV Allotropes and Solid Solutions: Nanoparticles and Nanowires. *Chemistry of Materials*, 32, 2703.
- [2] Fadaly, E.M.T. (2020). Direct-bandgap emission from hexagonal Ge and SiGe alloys. *Nature*, 580, 205.
- [3] Hannon, J.B. (2006). The influence of the surface migration of gold on the growth of silicon nanowires. *Nature*, 440, 7080.
- [4] Dudko, I. (2022). Hexagonal Ge Grown by Molecular Beam Epitaxy on Self-Assisted GaAs Nanowires. *Crystal Growth & Design*, 22, 32-36.
- [5] Dursap, T. (2021). Wurtzite phase control for self-assisted GaAs nanowires grown by molecular beam epitaxy. *Nanotechnology*, 32, 155602.

Acknowledgment:

This project has received funding from the European Union's Horizon 2020 research and innovation programme under the Marie Skłodowska-Curie grant agreement No 801512.