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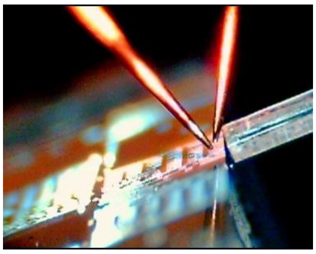

Summary

Master's Thesis at IHT

Title: Investigating SiGeSn/GeSn Double Heterostructures and Multiple Quantum Wells for LED Applications.

Bildquelle: „Elektrisch gepumpter Kantenemitter mit Glasfaserkopplung“, IHT, Universität Stuttgart

IHT field of competence „Photonic“

Keywords

GeSn LED, Crystal Analysis, Multi-quantum well, Relaxation, Direct Bandgap.

Summary: In previous work, Silicon-Germanium-Tin/Germanium-Tin microring resonators grown via chemical vapor deposition successfully achieved lasing with pulsed and continuous injection currents at temperatures up to 95K and 57K, respectively. The goal of this work was to further improve the laser characteristics by using an optimized layer stack grown by molecular beam epitaxy. The improved homogeneity of the quantum wells and a high silicon content in the barriers were verified using transmission electron microscopy electron microscopy and X-ray diffractometry.

Microring resonators were fabricated from the optimized layer stacks. Due to the faulty electrical and optical characteristics, the focus of this work shifted to investigating the causes of these results. Analyses such as X-ray diffractometry, transmission electron microscopy, and Raman spectroscopy identified partial relaxation of the GeSn layers with defect formation within the space charge region as the main cause. The cause of the relaxation was the surpassing of the critical layer thickness during heteroepitaxy.

Samples with a lower overall thickness of the GeSn layers showed little or no relaxation and were further investigated for their electroluminescence. It was found that the nominally direct semiconductor material behaved like an indirect semiconductor due to the quantization in the quantum well. The necessary adjustments in the design of the multi-quantum well structure were calculated and can be directly integrated into future designs to improve directness and emission efficiency, ultimately achieving optimal laser performance.

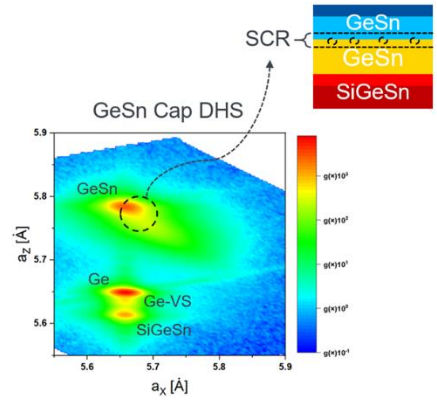

Fig. 1: RSM of a GeSn DHS sample showing a relaxation in the GeSn peak.

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