Annual Meeting

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Stefan Meyer Institute, Austrian Academy of Sciences

AUSTRIAN PHYSICAL SOCIETY

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ÖAW

STEFAN-MEYER-INSTITUT FÜR SUBATOMARE PHYSIK

THU08

14:45-15:00

Fabrication of ZnO-based Resonant Tunneling Diodes for Quantum Cascade Structures

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1. Introduction

The terahertz (THz) spectral range (lambda ~ 30µm ~ 300µm) is also known as the "THz-gap" because of the lack of compact semiconductor sources. Various real-world applications would strongly benefit from such devices, like trace gas spectroscopy or security screening. A crucial step for this is the operation of THz-emitting lasers at room temperature. But this seems out of reach with current devices, of which GaAs-based quantum cascade lasers (QCLs) seem to be the most promising ones. They are limited by the parasitic, non-optical LO-phonon transitions (36meV in GaAs), being on the same order as the thermal energy at room temperature (kT = 26meV). One possibility to solve this issue, is the use of larger LO-phonon materials like ZnO (ELO = 72meV). But to master the fabrication of ZnO-based QC structures, a high quality epitaxial growth is crucial followed by a well-controlled fabrication process including (selective) ZnO/ZnMgO etching and depositing low resistance ohmic contacts.

2. Results

Our devices are grown on m-plane [10-10] ZnO-substrate by molecular beam epitaxy (MBE) and patterned by reactive ion etching (RIE) in a CH4-based chemistry (ICP-power: 200W, RF-voltage: 500V, temperature ~ 30°C, gas-flow: 30/3/3 sccm (CH4/H2/Ar), chamber pressure: 20mTorr). The CH4-process protects the mask by depositing an amorphous carbon-layer and can result in up to infinitely high selectivity towards a resist mask [1]. We tested Au, resist and SiN as masking material, out of which SiN shows the best results, i.e. vertical sidewalls for 10µm of ZnO etching, a selectivity of well above 1:30 and an etch-rate of 62nm/min. The slightly rough surface of the etched ZnO is smoothed by an additional wet etching in diluted H3PO4. In a first experiment we measured the current-voltage characteristic of 50µm to 150µm square mesas for