

Annual Meeting

September 27th-29th, 2016

Faculty of Physics, University of Vienna
Stefan Meyer Institute, Austrian Academy of Sciences

AUSTRIAN PHYSICAL SOCIETY



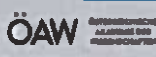
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STEFAN-MEYER-INSTITUT
FÜR SUBATOMARE PHYSIK

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 ($\lambda = 30\mu\text{m} - 300\mu\text{m}$) 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 ($kT = 26\text{meV}$). 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 10 μm 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 50 μm to 150 μm square mesas for

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