Applied Quantum Mechanics:
Sensing with Monolithically Integrated Quantum Cascade Devices

G. Strasser

Institute of Solid State Electronics, Technische Universität Wien, Vienna, Austria
Center for Micro- and Nanostructures, Technische Universität Wien, Vienna, Austria

gottfried.strasser@tuwien.ac.at

This talk aims to give a short introduction in the field of quantum devices with a strong focus on quantum cascade lasers (QCLs) and quantum cascade detectors (QCDs). Since the first proposal using intraband transitions in QWs to achieve lasing (Kazarinov and Suris in the seventies) and their first experimental realization at Bell Laboratories in the nineties intraband and interband cascade lasers have been intensively studied in terms of bandstructure engineering, cavity design and fabrication technology. Nowadays, QC lasers are compact and coherent light sources covering the spectral range from the mid-infrared to the terahertz region.

A bi-functional QC structure will be presented, that can be operated in two modes, as coherent light emitter as well as intraband detector, depending on the bias applied to the structure. Today, photonic devices are widely used in environmental and industrial process control and/or monitoring as well as medical and biochemical diagnostics. Conventional optical sensing setups include a light source, a light-analyte interaction region and a separate detector. We developed and improved a sensor concept based on a bi-functional quantum cascade heterostructure, for which the differentiation between laser and detector is eliminated. Apart from the fascinating physics of light-matter interaction, this enables mutual commutation of laser and detector, simplifies remote sensing setups and allows crucial miniaturization of sensing devices for further integration.