A Merten et al., J Laser Opt Photonics 2018, Volume 5
DOI: 10.4172/2469-410X-C1-023

Miniaturized tunable QCL - lightsource for MID-infrared spectroscopy

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Broadband tuning of MIR-infrared radiation from 3 to 10 µm is a very promising way for spectroscopic study of gaseous, liquid, or solid species or intermixtures. We report a fast broadband tunable IR-light source based on the combination of a quantum-cascade-laser and a micro-opto-electro-mechanical systems (MOEMS) with integrated diffractive grating. This concept unites the advantages of broadband sources with the advantages of coherent laser sources in a miniaturized setup. The diffraction grating is processed inline within the MOEMS production process by non-isotropic etching. Grove depth and thus maximum spectral diffraction efficiency is determined by lithographic mask and the etch-parameters. The scanning MOEMS-grating is driven electrostatically and oscillates with high repeatability at resonance frequency of 1 kHz and up to 10° deflection, which allows scanning the entire spectral range of the QCL-chip within 500 µs. This opens the way for real-time spectroscopy in the MID-IR range. We present applications in non-contact detection of hazardous species e.g. explosives and inline-detection oil contamination in water.

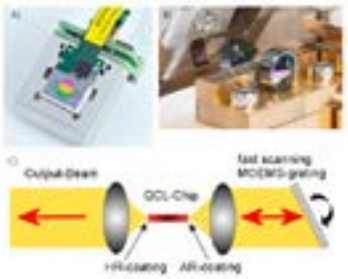

Figure 1: A) MOEMS-grating module; B) MOEMS-grating, collimation lenses and QCL-chip forming the external cavity-QCL; C) Scheme of external cavity QCL with MOEMS-grating.

Recent Publications

1. Butschek L, Hugger S, Jarvis J, Haertelt M, Merten A, Grahmann J, Stothard D Warden, Carson C, Macarthur J, Fuchs F, Schilling C, Ostendorf R, Rattunde M and Wagner J (2017) Micro opto electromechanical systems-based external cavity quantum cascade lasers for real-time spectroscopy. Optical Engineering 57(1):011010.
2. Ostendorf R, Butschek L, Merten A, Grahmann J, Jarvis J, Hugger, S, Fuchs F and Wagner J (2016) Real-time spectroscopic sensing using a widely tunable external cavity-QCL with MOEMS diffraction grating, Proceedings Volume 9755.
3. Wagner J, Ostendorf R, Grahmann J, Merten A, Hugger S, Jarvis J, Fuchs F, Boskovic D and Schenk H (2015) Widely tuneable quantum cascade lasers for spectroscopic sensing 9370.
4. Grahmann J, Merten A, Ostendorf R, Fontenot M, Bleh D, Schenk H and Wagner J (2013) Tunable Exterternal Cavity Quantum Cascade Lasers (EC-QCL): an application field for MOEMS based scanning gratings. Proc. SPIE 8977
5. Hugi A, Maulini R and Faist J (2010) External cavity quantum cascade laser. Semiconductor Science and Technology 25(8):83001.

Biography

A Merten received his Diploma-degree in Physics from Friedrich-Schiller-University Jena (Germany) in 2003. Following he was a PhD student at Institute of Environmental Physics in Heidelberg and worked on differential optical absorption spectroscopy (DOAS) of atmospheric trace gases. Afterwards he joined the Institute of Applied Photo Physics (IAPP) at the Technical University in Dresden and worked on the optical simulation and characterization of thin film organic solar cells. He joined the Fraunhofer Institute for Photonic Microsystems (IPMS) in 2012 and is working on the opto-mechanical system design of miniaturized projectors and 3D-LIDAR cams involving MEMS scanners as well on the optical characterization of MEMS based scanner mirrors.

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