

3rd International Conference and Exhibition on Lasers, Optics & Photonics

September 01-03, 2015 Valencia, Spain

Recent advances in widely tunable quantum cascade lasers and their use in spectroscopic sensing

J Wagner¹, R Ostendorf¹, J Grahmann², A Merten², S Hugger¹, J-P Jarvis¹, F Fuchs¹ and H Schenk² ¹Fraunhofer Institute for Applied Solid State Physics, Germany ²Fraunhofer Institute for Photonic Microsystems, Germany

Widely tunable quantum cascade lasers (QCL) are ideal light sources for spectroscopic sensing exploiting characteristic finger print absorption of molecules in the mid-infrared (MIR) spectral range. Such broadband tunability can be achieved by placing a QCL chip with a broad gain spectrum into an external cavity (EC-QCL), using e.g. a diffractive grating as wavelength-dependent feedback-element. This way wavelength tuning over >25% of the central wavelength can be achieved routinely in the MIR spectral range. EC-QCLs deliver a well collimated low-divergence output beam with high spectral brightness, which enables a range of new applications. These include in-line MIR spectroscopic sensing of substances in aqueous solutions and MIR backscattering spectroscopy for stand-off detection of hazardous substances. First we report on recent advances in broadband-tunable MIR EC-QCL technology by presenting a first implementation of a rapid scan EC-QCL, employing a custom-made large diameter (\emptyset =5 mm) MOEMS scanning grating in Littrow-configuration as wavelength scans per second. Second, exemplary case studies of EC-QCL based MIR spectroscopy will be presented. These include in-line spectroscopy for the detection of contaminants in water as well as imaging MIR backscattering spectroscopy for the detection of residues of explosives and related precursors on various kinds of surfaces in a realistic environment.

Biography

J Wagner received PhD degree in Physics from the University in Stuttgart, Germany, in 1982. From 1982 to 1984 he worked at the Max Planck Institute for Solid State Research, Stuttgart, Germany, in the group of Prof. M Cardona before joining the Fraunhofer-Institute for Applied Solid State Physics, Freiburg, Germany, in 1985. There he is currently Deputy Director and Head of the Optoelectronics Department. He is also Professor at the Institute of Physics of the University of Freiburg and an associated member of the Materials Research Center Freiburg (FMF). His current research interests include III/V-semiconductor based optoelectronic devices in particular for the infrared spectral range, as well as their integration into modules and systems. He is author or coauthor of 460 scientific publications including several review papers and book chapters.

Joachim.Wagner@iaf.fraunhofer.de

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