Bi-functional Quantum Cascade Detectors/Lasers

M. Beiser[1*], B. Schwarz [1], A. Harrer [1], M. Holzbauer [1] H. Detz [3], A.M. Andrews[1], G. Strasser[1, 2]

[1] *Institute for Solid State Electronics and Center for Micro- and Nanostructures, TU Wien, Floragasse 7, 1040 Wien, Austria*
[2]*Center for Micro and Nanostructures, TU-Wien, Floragasse 7, 1040 Wien, Austria*
[3] *Austrian Academy of Sciences, Dr. Ignaz Seipel-Platz 2, 1010 Wien, Austria*

The recent straightforward implementation of a bi-functional QCLD opened the gate widely for new concepts of on-chip detection in the mid-infrared [1]. The mid-infrared is very interesting as the fundamental absorption lines of molecules like water and carbondioxide lie in there. Also the recent development of an integrated structure with an watt-level output power lever at room temperature increases the attractivity for chemical and biological sensing. An example for such a structure is displayed in figure 1 on the right.

Another way to implement the on-chip concept, is the use of a surface emitting ring QCL with an integrated detector [2]. A prototype for this was tested with isopropanol and water and showed a detection limit of 50 ppm.

The link to epitaxial growth for Bi-functional devices is the quality of the layers for the QCL. The improvement of the layer quality needs optimization of band-structure and wavefunction modeling and also advanced processing of fabrication and epitaxial regrowth [3], [4].

In this contribution it will be displayed, how the recent progress has evolved and how it is connected to improvement of MBE techniques. The possible outlook of this recent developments is the implementation of frequency combs on an on-chip device.

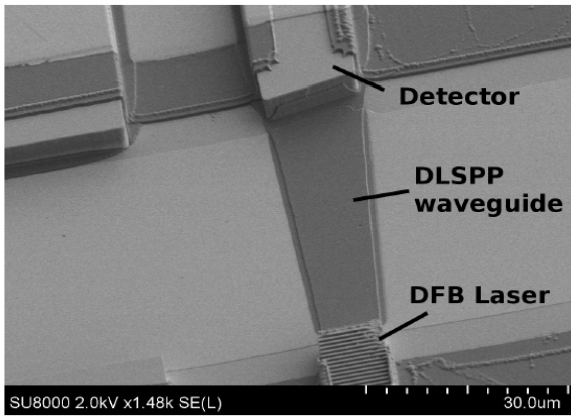

Fig. 1: SEM Image of a DFB laser, a DLSPP waveguide and the detector unit building a bi-functional device

[1] B. Schwarz, C.A. Wang, L. Missaggia, T.S. Mansuripur, M.K. Connors, D. McNulty, J. Cederberg, G. Strasser, and F. Capasso, *ACS Photonics* **2017** *4* (5), 1225-1231.

[2] A. Harrer, R. Szedlak, B. Schwarz, H. Moser, T. Zederbauer, D. MacFarland, H. Detz, A.M. Andrews, Bernhard Lendl, W. Schrenk, and G. Strasser, *Sci. Rep.*, **107**, 6:21795 (2016).

[3] C.A. Wang, B. Schwarz, D. Siriani, , L. Missaggia, M.K. Connors, T. Mansuripur, D. R. Calawa, D. McNulty, M. Nickerson, J.P. Donnelly, K. Creedon and F. Capasso, *IEEE Q. Elec.*., **23**, No. 6 (2017).

[4] C.A. Wang, B. Schwarz, D. Siriani, M. Connors, L. Missaggia, D. Calawa, D. McNulty, A. Akey, M.C. Zheng, J.P. Donnelly, T. Mansuripur, F. Capasso, *IEEE J.o. Crystal Regrowth,* **464**, 215-220 (2016).

*Contact: maximilian.beiser@tuwien.ac.at