Julius-Maximilians-
UNIVERSITÄT
WÜRZBURG

German Molecular Beam Epitaxy 2019 (DEMBE2019)

Würzburg, Free State of Bavaria, Germany
From 7th -- 8th October 2019

Web: https://www2.uni-wuerzburg.de/dembe2019
e-mail: dembe2019@physik.uni-wuerzburg.de

Monolithic Frequency Comb Generation and High-speed Detection based on Interband Cascade Structures

M. Beiser,[1,*] **J. Hillbrand**[1], **A. M. Andrews**[2], **R. Weih**[3], **S. Höfling**[4], **G. Strasser**[1], **and B. Schwarz**[1]
[1]*Institute of Solid State Electronics, TU Wien, 1040 Wien, Austria*
[2]*Center for Micro- and Nanostructures, TU Wien, 1040 Wien, Austria*
[3]*Nanoplus Nanosystems and Technologies GmbH, 97218 Gerbrunn, Germany*
[4]*Technische Physik, Physikalisches Institut, University Wuerzburg, Am Hubland, 97074 Wuerzburg, Germany*
*Corresponding author: *mbeiser@tuwien.ac.at*

Frequency combs are sources of coherent light whose frequency spectrum is composed of a multitude of equidistant lines. Originally developed in the near-infrared region, frequency combs enabled unprecedented precision of applications such as time metrology and frequency synthesis. The mid-infrared region is attracting a lot of research interest. because no other spectral region provides the same sensitivity or selectivity for molecular fingerprinting. Interband cascade lasers (ICL) are particularly appealing for frequency comb generation because they are electrically pumped and have a small footprint. We present a new monolithic frequency comb sensing platform based on ICLs. We demonstrate self-starting frequency comb operation of ICLs based on the inherent gain non-linearity. In contrast to QCLs, the gain in ICLs is provided by an interband transition rather than an intersubband transition. Despite the fact that the laser transition lifetime differs by more than two orders of magnitude compared to QCLs, ICLs can respond to beatings between laser modes (Fig. 1a). We investigate the laser dynamics of the ICL frequency comb using a linear autocorrelation technique (Fig. 1b). Our experiments reveal that ICL frequency combs are characterized by a strong suppression of amplitude modulation. We further show that ICL combs can be locked to an external RF oscillator while maintaining full intermodal phase coherence. Finally, we highlight the unique detection functionality naturally provided by the ICL material, which can be used to directly integrate sensitive multi-heterodyne detectors.

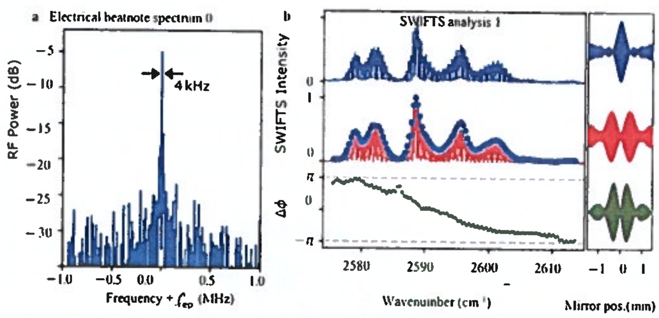

Figure 1: **a**: Beatnote of the frequency comb modes at the cavity roundtrip frequency. **b**: Anal- ysis of the frequency comb using SWIFTS. blue: intensity spectrum. red: coherence spectrum. green: intermodal phase differences.

References

[1] B. Schwarz, J. Hillbrand, M. Beiser, A. M. Andrews, G. Strasser, H. Detz, A. Schade, R. Weih, and S. Höfling, Optica 6, 890-895 (2019)

[2] A. Hugi, G. Villares, S. Blaser, H. C. Liu, and J. Faist, Nature 492(7428), 229 (2012)