optica

Picosecond pulses from a mid-infrared interband cascade laser: supplementary material

JOHANNES HILLBRAND[1,*], MAXIMILIAN BEISER[1], AARON MAXWELL ANDREWS[1], HERMANN DETZ[2,3], ROBERT WEIH[4], ANNE SCHADE[5], SVEN HÖFLING[5,6], GOTTFRIED STRASSER[1,2], AND BENEDIKT SCHWARZ[1,*]

[1] *Institute of Solid State Electronics, TU Wien, Vienna, Austria*
[2] *Center for Micro- and Nanostructures, TU Wien, Vienna, Austria*
[3] *Central European Institute of Technology, Brno University of Technology, Brno, Czech Republic*
[4] *Nanoplus Nanosystems and Technologies GmbH, 97218 Gerbrunn, Germany*
[5] *Technische Physik, Physikalisches Institut, University Würzburg, Am Hubland, 97074 Würzburg, Germany*
[6] *SUPA, School of Physics and Astronomy, University of St Andrews, St Andrews, KY16 9SS, United Kingdom*
[*] *Corresponding authors: johannes.hillbrand@tuwien.ac.at, benedikt.schwarz@tuwien.ac.at*

Published 10 October 2019

This document provides supplementary information to "Picosecond pulses from a mid-infrared interband cascade laser," https://doi.org/10.1364/optica.6.001334.

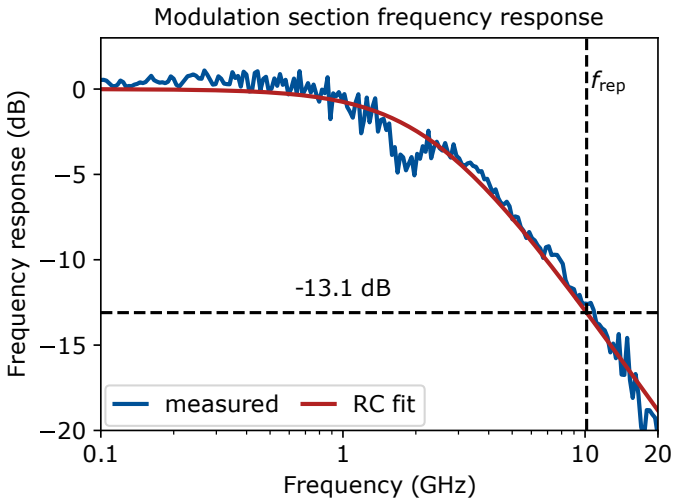

Fig. 1. Frequency response of a 320 µm long modulation section measured using microwave rectification. Blue curve: measured frequency response using microwave rectification. Red curve: fit using a first order lowpass (RC) behaviour, where R=50 Ω and C=1.4 pF. The 3 dB cutoff frequency is 2.9 GHz.

The active region of the ICL is comprised of 6 cascades and is 350 nm thin. This results in a parasitic capacitance of approximately 1.4 pF. The resulting lowpass behavior shows a 3 dB cutoff frequency of roughly 2.9 GHz. At 10.15 GHz, the injected modulation signal is damped by 13.1 dB. Hence, 18.9 dBm of the total modulation signal (32 dBm) in Fig. 4 effectively contribute to the modulation. This corresponds to roughly 80 mW of RF power. In comparison, the DC power that would be flowing through the modulation section if it was biased the same as the gain section in Fig. 4 of the main text (approximately 4.2 V) is 110 mW.

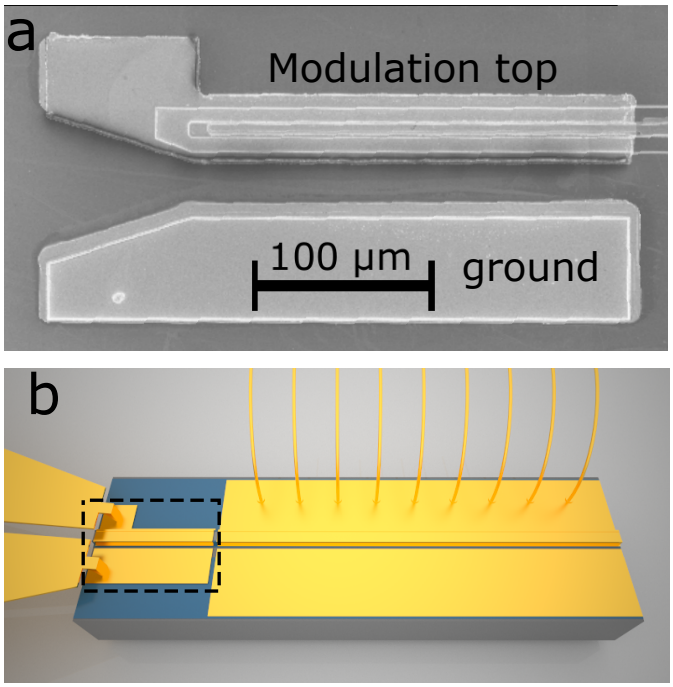

Fig. 2. **a**: Scanning electron microscope picture of the top contact (top) and ground contact (bottom) of a 320 µlong absorber section, as seen in Fig. 1 of the main text. The gold pads on the very left are optimized for connection to 40 GHz RF tips with 100 µm pitch. **b**. 3D sketch of the entire device including RF tips touched down on the modulation section. The dashed area highlights the modulation section shown in **a**.

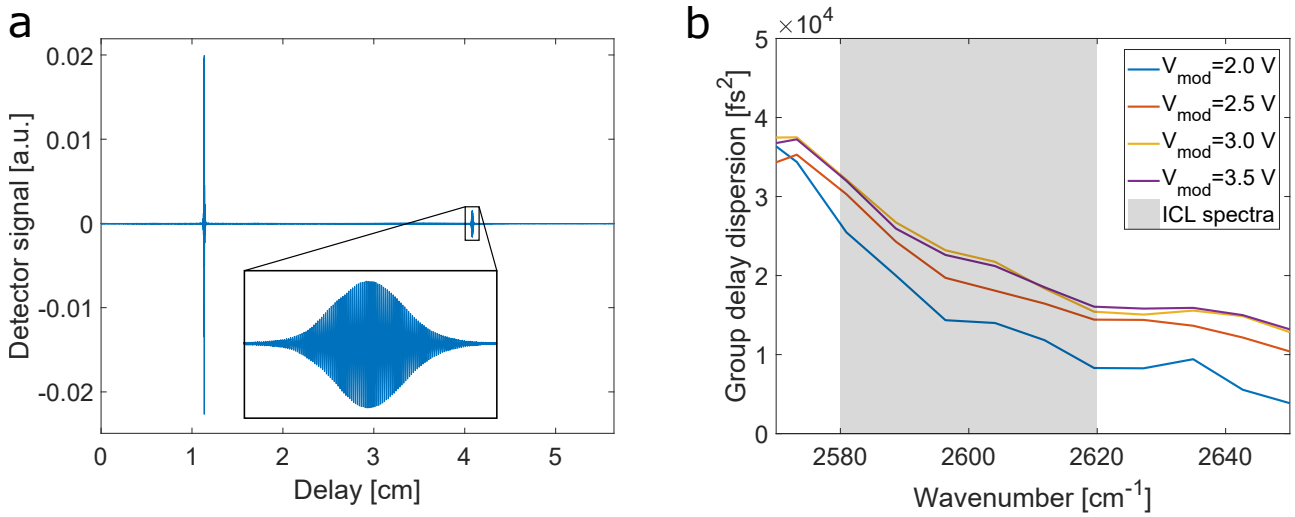

Fig. 3. Dispersion in a 6 µm wide and 4 mm long ICL ridge laser: (**a**): interferogram of the light emitted by the ICL when driven slightly below lasing threshold using an InSb detector. The interferogram consists of a large central burst as well as a satellite burst at a delay corresponding to exactly on cavity roundtrip in the ICL. The group delay dispersion of the ICL is obtained by applying a Fourier transform to the first satellite burst and computing the second derivative of the complex spectral phase. (**a**): GDD of the ICL for different absorber bias conditions.