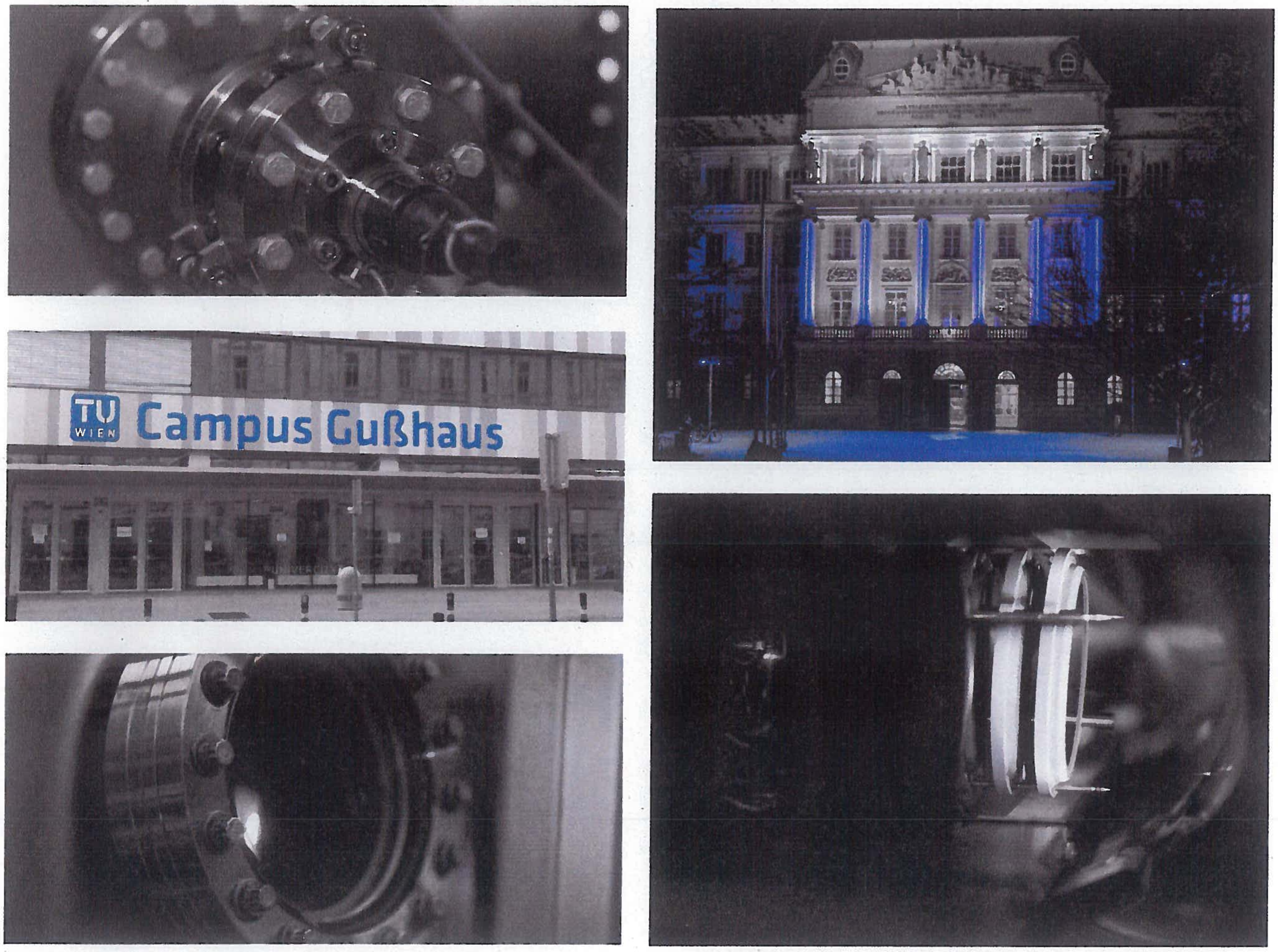
Austrian MBE Workshop 2017

28. - 29. September 2017

Vienna



Single Period Quantum Cascade Detector

B. Schwarz [1*], P. Reininger[1], A. Harrer [1], D. MacFarland[1], H. Detz[3], A.M. Andrews[1], W. Schrenk[2] and G. Strasser[1,2]

[1] *Institute of Solid State Electronics, 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, Doktor-Ignaz-Seipel-Platz 2, 1010 Wien, Austria*

Quantum cascade detectors (QCD) were under extensive investigation during the past years. Their room temperature operation properties, operation speed and integration to bi-functional quantum cascade laser detector [1] structures results in a variety of promising applications.

Typically a standard quantum cascade detector active region design consists of 20 up to 40 periods. For 45° polished facet mesa geometries, this is a good trade-off between the reachable responsivity and the differential resistance.

With a high resistance active region design, the number of periods can be reduced to increase the responsivity and maintain a high differential resistance of the device. This approach is efficient utilizing absorber structures which compensate for the lower absorption of the active zone as a result of the low number of periods. A straight forward geometry which can be used, is a facet illuminated ridge with the active zone embedded into a dielectric low loss waveguide.

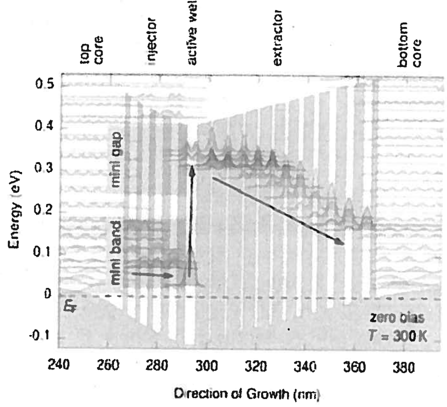


Fig. 1: Single period active region with a mini gap to prevent carrier losses and a mini band for efficient carrier injection to the ground level.

The ridge waveguide offers a long absorption length and thereby high absorption. A highly doped substrate prevents light coupling only to the front facet of the ridge. With a single period active region and the ridge coupling scheme a responsivity as high as 0.86A/W at room temperature with an external quantum efficiency of 25% (without ARC) could be shown. The specific detectivity obtained is 7,2x10^7Jones at 300K for the operation wavelength at 4.1µm [2].

These results show a significant improvement over previously reported QCD performance and provides a model for the performance limits of QCDs.

[1] B. Schwarz, D. Ristanic, P. Reininger, T. Zerderbauer, D. MacFarland, H. Detz, A.M. Andrews, W. Schrenk and G. Strasser, Appl. Phys. Lett. 107, 071104 (2015)

[2] B. Schwarz, P. Reininger, A. Harrer, D. MacFarland, H. Detz, A.M. Andrews, W. Schrenk and G. Strasser, *Appl. Phys. Lett.*, **111**, 061107 (2017).

*Contact: benedikt.schwarz@tuwien.ac.at