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Optical Control of Terahertz Quantum Cascade Random Lasers

Sebastian Schönhuber^{1,2}, Benedikt Limbacher^{1,2}, Martin A. Kainz^{1,2}, Dominik Theiner^{1,2}, Michael Jaidl^{1,2}, Aaron M. Andrews^{2,3}, Hermann Detz^{2,4}, Gottfried Strasser^{2,3}, Juraj Darmo^{1,2} and Karl Unterrainer^{1,2}

1. Photonics Institute, TU Wien, 1040 Vienna, Austria

2. Center for Micro-and Nanostructures, TU Wien, 1040 Vienna, Austria

3. Institute of Solid State Electronics, TU Wien, 1040 Vienna, Austria

4. Central European Institute of Technology, Brno University of Technology, 61200 Brno, Czech Republic

Since their initial demonstration, random lasers have attracted a lot of interest due to their complementary characteristics compared to conventional lasers [1]. In a random laser, the light is trapped by multiple scattering in the gain medium, which has been demonstrated in different kinds of materials, ranging from grinded laser crystals to polymer films and ceramics. Recently we demonstrated [2] random lasers at terahertz (THz) frequencies by making use of quantum cascade laser (QCL) active regions, resulting in broadband surface emission with a highly collimated output beam. We realized random lasers by etching a random air hole pattern through the active region of a double-metal waveguide. Due to the frequency independent feedback mechanism, broadband surface emission is achieved, covering a bandwidth of more than 350 GHz. This is the distinctive feature compared to previously demonstrated concepts providing surface emission which are designed to support a single lasing mode only. Furthermore, the electrically pumped nature of the used quantum cascade active region allows for highly controllable experimental conditions and is also crucial for potential future applications. Here, we demonstrate a tunable broadband terahertz source by optically modulating the random laser with an external illumination source [3] at 813 nm, as depicted in the scheme in Fig. 1 (a). The additional light allows spatially resolved, independent modulation of gain and loss properties. This modulation results in changes in the QCL spectrum. By further optimization of the modulation scheme, our results will pave the way towards a continuously tunable broadband terahertz light source.

References

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*Contact Email: sebastian.schoenhuber@tuwien.ac.at

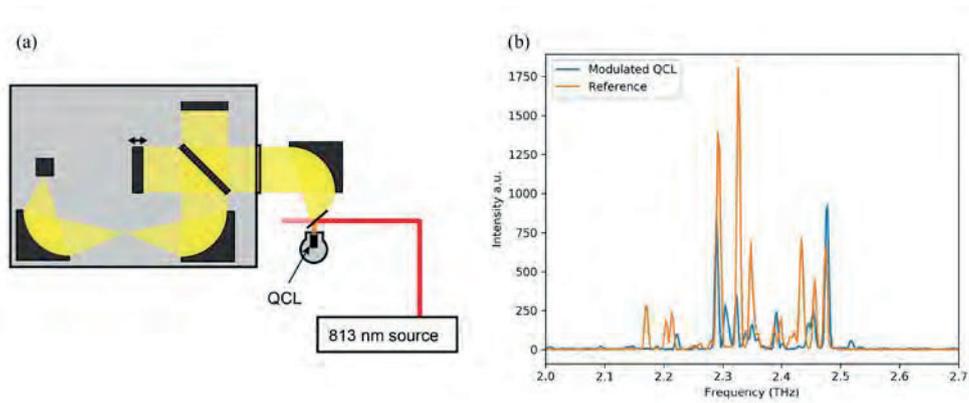


Figure 1:(a) Scheme of the experimental setup. (b) Comparison of spectra recorded with and without additional optical illumination. Occurring modes of the terahertz random laser are modified if an additional 813 nm beam is focussed onto the devices, introducing a spatial loss modulation which favours different modes. This is a caption for a figure.