THz Generation and Devices: Design, Fabrication and Characterization

by

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Abstract

The THz frequency band (0.1 – 10 THz) is located in between the well explored optical frequencies and the microwave band. Despite growing research efforts in the last two decades, THz sensing systems are far from robust and cost effective. The development of passive devices for THz applications like waveguides, filters, reflectors and modulators is in the beginning of being established. This work contributes to the field by introducing novel polymer filter structures and a new design of THz fibers. These passive devices are fabricated by using a fiber drawing technique to scale down inscribed patterns in polymer to the THz wavelengths. Moreover, the revolutionary quasi time-domain spectrometer approach is further extended to suit varying sensing applications.

This work is structured in four chapters. The first chapter describes THz fundamentals and state-of-the-art THz systems for common time-domain (TDS) and continuous wave (CW) spectrometers. The generation and detection principles are discussed in detail and typical system designs are presented.

In the second chapter the fabrication and design process of polymer photonic crystal THz waveguides is presented. An improved near-field THz TDS system is introduced to verify the mode distributions. In addition, a new approach for improving the confinement and stripping of undesired higher order modes is demonstrated.

Chapter three presents a new polymer filter structure. The fabrication process scales down inscribed features in a polymer preform by fiber drawing. Thus it is possible to obtain hole diameters of 200 µm and below, which could not be mechanically fabricated. The structures are first simulated and afterwards analyzed by a standard THz TDS system.

The last chapter is based on the novel quasi time-domain spectrometer approach introduced by Scheller in 2009 [Optics Express, Vol. 17, Issue 20]. The CW based generation and detection scheme is presented and in cooperation with the author, a hybrid THz spectrometer and imaging capability is demonstrated. A second system approach – a dual QTDS spectrometer - is set up, demonstrating that QTDS has the potential for customized low-cost and robust THz systems.

Statement of Candidate

I certify that the work in this thesis entitled "**Polymer based THz Fibers and Filters: Design, Fabrication and Experimental Characterization**" has not previously been submitted for a degree nor has it been submitted as part of requirements for a degree to any other university or institution other than Macquarie University and the Technical University of Braunschweig, Germany.

I also certify that the thesis is an original piece of research and it has been written by me. Any help and assistance that I have received in my research work and the preparation of the thesis itself have been appropriately acknowledged.

In addition, I certify that all information sources and literature used are indicated in the thesis.

Matthias Stecher (41264347)

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