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Institut für Elektrotechnik, Elektronik und Informationstechnik

Terahertz technology and its biomolecular sensing potential

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The terahertz (THz) frequency range, roughly defined as extending from 300GHz to 10THz, is one of the long-standing breaches in the electromagnetic spectrum. Developments in the last decades have led to the development of highly sophisticated systems routinely operating in this frequency range, which are used to great benefit in fields such as astronomy or atmospheric sensing. However, until recently, this spectral region has resisted attempts to broadly harness its potential for everyday applications. This led to the expression THz gap, loosely describing the lack of adequate technologies to effectively bridge this transition region between microwaves and optics. However, in the last years extensive research and nanotechnology efforts have paved the technological path towards broadly usable THz systems which are now used to explore various application areas. This presentation will provide a short overview of THz technology and its biomedical applications. Then, it will describe in more detail THz-wave based biomolecular sensing approaches for the label-free characterization of genetic material. As demonstrated by recent time-resolved THz spectroscopic analysis genetic sequences exhibit a clearly distinct complex refractive index in the THz frequency range as a function of the hybridization state (hybridized / denatured) of the analysed DNA sequences. By monitoring THz signals one can thus selectively infer the binding state of oligo- and polynucleotides, enabling the label-free determination of the genetic composition of polynucleotides. A broadband experimental proof-of-principle in a free-space configuration, as well as integrated label-free biochip sensing arrays exhibiting high-sensitivity and single base mutation detection capabilities are presented. An overview of recent developments is presented in [1].

1. P. Haring Bolivar, M. Nagel, F. Richter, M. Brucherseifer, H. Kurz, A. Bosserhoff und R. Büttner, “Label-free THz sensing of genetic sequences: towards 'THz biochips' ”, Phil. Trans. Roy. Soc. Lond. A 362, 323 - 335 (2004).