Terahertz Waveguides and Materials

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***Abstract*— In this paper we compare the Terahertz absorption coefficients and refractive indices for bulk glasses (F2 and Bismuth) and a polymer (PMMA) and investigate the suitability of these materials for Terahertz waveguides.**

I. Introduction

Over the last decade, Terahertz (THz) spectroscopic techniques have attracted a significant interest, due to their application in detection of biological and chemical materials [1]. Low loss THz transmission is one of the main issues of these techniques. To date, metal parallel plates [2] and bare metal wires are the promising metal-based guiding techniques reported in the literature with attenuation constants less than 0.3 cm^{-1} [3] and 0.03 cm^{-1} [4] respectively. Chen et al. [5] have recently reported loss values less than 0.01 cm^{-1} near 0.3 THz in plastic fibers. Here, we present the measured absorption coefficients and refractive indices of three bulk materials, a polymer (PMMA) and two glasses (F2 and Bismuth) and discuss the suitability of using these materials for non-metallic THz waveguides.

II. Experimental Setup and Measurements

To measure the refractive indices and absorption coefficient, we used a commercially available THz time-domain spectrometer (Picometrix T-Ray 2000^{TM}) driven by a Mai-Tai femtosecond laser with a pulse width of less than 100 fs, central frequency of 800 nm and a repetition rate of 80 MHz [6]. The material samples were obtained from the Centre of Expertise in Photonics and were 35 mm, 16 mm and 9 mm thick, polished disks (diameter of 5 cm) of PMMA, F2, and Bismuth, respectively. The absorption coefficients and refractive indices were obtained by comparing the sample pulses with a reference pulse propagating through dry air.

Individually, the refractive index of each glass sample is significantly higher than the refractive index of the PMMA sample. This results in a tighter confinement of the terahertz radiation in the glass material of a waveguide because of the increased air-glass contrast. Analytical study of potential waveguide structures of these materials reveals that the loss is a function of diameter, refractive index and the waveguide structure thus increasing the potential exploitation of these materials as waveguides.

Fig. 1 shows the absorption coefficients [7] of these materials in the low THz range. Due to the fact that the samples in this preliminary study were relatively thick, the dynamic range of the experiment was restricted to frequencies below one THz.

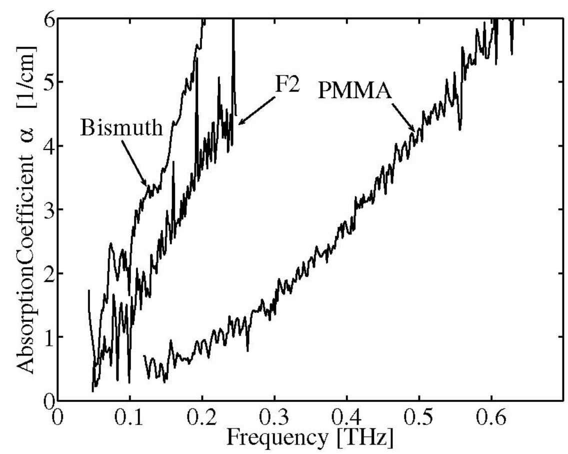

Fig. 1. Absorption coefficients of PMMA, F2 and Bismuth

Further experiments on thinner samples will be investigated to increase the dynamic range.

III. Conclusion

The absorption coefficients of two glasses (F2 and Bismuth) and a polymer (PMMA) have been measured and compared for low terahertz frequency regime. The feasibility of exploiting these materials for THz waveguides, as well as their applications, are discussed.

References

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