Design and Fabrication of Terahertz Bragg Gratings on a Two-Wire Waveguide

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***Abstract*— In this study, we present the design and the fabrication procedure of waveguide-integrated Bragg Gratings operating at THz frequencies.**

Keywords—Terahertz, Bragg Gratings, Two-Wire Waveguide;

I. Introduction

Recently, terahertz (THz) communication has become an active research topic, driven by the availability of unregulated bandwidth and the promise of much higher transmission rates, compared to microwave communications [1]. Waveguides are one of the key components for the development of future THz communications. Multiple THz guiding structures have been developed in recent years, e.g. metal pipes, dielectric fibers and parallel plates. However, they all suffer from either high losses or large dispersion, which hampers THz pulse propagation over long distances. Two-wire waveguides (TWWGs) provide both low loss and dispersion-free propagation. Moreover, TWWG has the important advantage of allowing the propagation of TEM modes, thus offering efficient coupling for the radiation emitted by common THz sources [2]. TWWG-based THz Bragg Gratings (BGs) have been previously implemented by suspending a polymer or paper mesh between the wires [3, 4]. Here, we propose to improve this bulky setup by directly integrating the device into the TWWG. We report on the design and fabrication process of such THz-BG and also on the determination of its effective refractive indices and transmission properties.

II. Design of the terahertz Bragg gratings

The TWWG consists of two copper wires (254 μm diameter), covered by a layer of Kapton (127 μm thick) and separated by a distance of 300 μm. The BG is realized by alternating two contiguous sections of the waveguide, one fully covered with Kapton and the other one only half-covered with the same material. A side-view of the simulated THz-BG is illustrated in Fig. 1(a). For both of these sections, we determined the effective refractive index of the THz fundamental mode propagating within the waveguide, by means of the finite element software Comsol Multiphysics®. The simulated field distributions in the half- and the full-covered sections are shown in Fig. 1(c) and Fig. 1(d), respectively. Afterwards, we estimated the geometrical parameters of the BG to feature a resonance at 0.6 THz (i.e. length, pitch and duty cycle), by using the transfer matrix method implemented in Matlab®, considering the previously calculated effective refractive indexes. Based on these numerical results, we have fabricated a THz-BG. In order to minimize the absorption, we removed the Kapton covering the copper wires via thermal stripping, leaving only a 5 mm-long section at the center. Then, an excimer laser (KrF, 148 nm) was used to engrave the grooves on Kapton, by means of a micromachining process. An optical microscope image of the fabricated sample is shown in Fig.1(b).

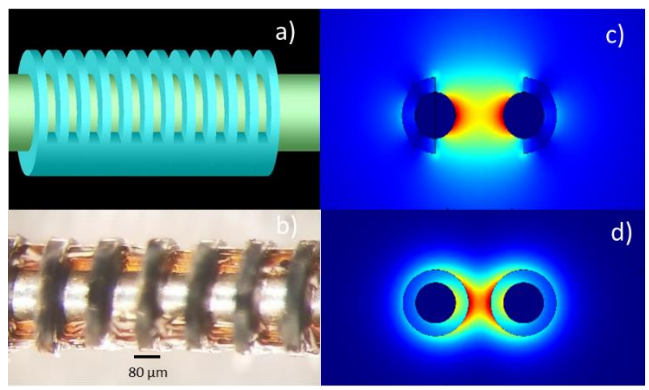

Figure 1: a) Side view of the BG; b) Optical microscope image of the fabricated sample; c-d) Simulated field distributions in two representative sections constituting a single period of the BG.

In conclusion, we present the design and fabrication process of a THz BG operating at 0.6 THz. Such proof-of-principle test could pave the way to the design and the implementation of novel waveguide-based devices for signal-processing, filtering, band equalization or dispersion management at THz frequencies.

III. References

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