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

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***Abstract*— In this study, we present the design, fabrication and experimental characterization of waveguide-integrated gratings operating at THz frequencies.**

Keywords—Terahertz, Gratings, Two-Wire Waveguide;

I. INTRODUCTION

Terahertz (THz) communications has become an active research topic in the last years, due to the rapidly increasing demand for higher bandwidth and data rates in wireless communication systems [1]. Waveguides are one of the key components for the development of future THz communications. Multiple guiding structures have been developed recently, e.g. metal pipes, dielectric fibers and parallel plates. However, they all suffer from either high losses, high dispersion or not perfect confinement, which hampers THz pulse propagation over long distances. Two-wire waveguides (TWWGs) allow to overcome these shortcomings. Moreover, they have the important advantage of allowing the propagation of Transverse ElectroMagnetic modes, thus offering efficient coupling for the radiation emitted by linearly-polarized THz sources, such as photoconductive antennas [2]. TWWG-based THz Bragg Gratings have been previously implemented by suspending a polymer or paper mesh between the wires [3, 4]. Here, we propose a new concept of grating structure, consisting in the direct fabrication of trenches into one wire of the TWWG. We report on the design, fabrication and experimental characterization of such a THz grating.

II. DESIGN OF THE TERAHERTZ METALLIC GRATINGS

The TWWG consists of two copper wires (254 µm diameter) separated by an air gap, whereas the grating is on only one wire of the TWWG. To find an optimal set of parameters that would allow us to produce a resonance at the desired frequency, i.e. 0.6 THz, we simulated the propagation of a THz pulse in the device. This was done by means of the software Lumerical FDTD Solutions®. The results are shown in Fig. 1(a) (blue line). During the fabrication process, a silicon wafer was first etched, in order to realize a trench where it is possible to place the wire. The grooves are then realized by means of a saw having a blade with a width of 100 µm. Optical microscope images of the fabricated sample are shown in Fig. 1(b-c). Finally, we performed its experimental characterization by using a typical THz Time-Domain Spectroscopy (THz-TDS) setup. Here, a photoconductive antenna was employed for the generation of the THz pulses, while detection was carried out via electro-optic sampling in a 3-mm-thick ZnTe crystal. The comparison between experimental (red line) and simulation (blue line) results is shown in Fig. 1(a). While the notch depth is comparable, we notice a small shift of the notch frequency, likely due to some slight differences in the geometrical parameters of the sample.

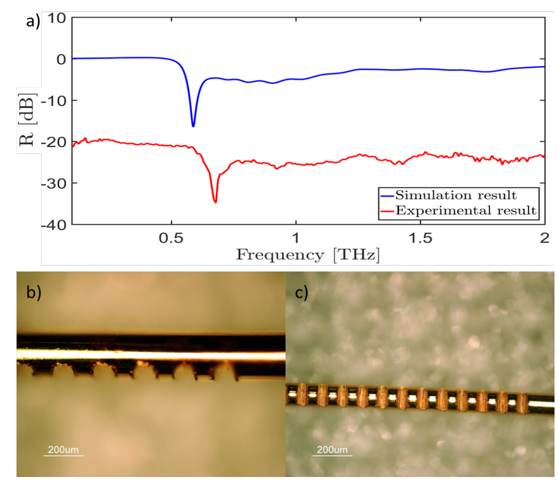

Figure 1: a) Simulation (blue line) and experimental (red line) spectra of the THz metallic grating, where R is defined as the ratio of the Power Spectral Density of the sample over the TWWG one, expressed in dB: (b-c) Optical microscope images of the fabricated sample.

Such a device can pave the way to the design and implementation of more complex waveguide-based devices for signal-processing functionalities at THz frequencies.

III. REFERENCES

[1] D. Saeedkia, Elsevier (2013).
[2] H. Pahlevaninezhad et al., Opt. Express, **18**, 7415 (2010).
[3] G. Yan et al., Opt. Lett., **38**, 3089-3092 (2013).
[4] M. K. Mridha et al., Opt. Express, **22**, 22340 (2014).