Authentication in the THz domain: a new tool to fight couterfeiting

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Authentication in the THz domain: a new tool to fight counterfeiting

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***Introduction**:* In the present work, we propose a new approach based on the use of the spectral signature of diffraction gratings engraved on one side of smart cards to be authenticated. The etched substrate acts as a dielectric waveguide associated to a 1D diffraction grating [1]. When the coupling conditions are verified, the reflected and transmitted THz spectra exhibit extinction lines (m-lines) that can be used as a broadband and rich spectral signature. For a given incident angle, the number of m-lines, their frequency positions and depth depend on the geometrical dimensions of the structure [2]. Hence, a unique etching scheme leads to a unique spectral signature. We first focused on simulations and experimental validation of the proposed authentication method that we would present to the 9^{th} THz days.

Structure and principle: The structure presented in Fig. 1.a. is constituted in a 1D rectangular diffraction grating engraved on a smart card using a LPKF Protomat C60 machine. The optical parameters of the cards are: thickness e_{card} = 760 ± 10 µm, absorption α~20 cm^{-1} and refractive index n~1.72 @ 1 THz. The transmission and reflection of whole structure is simulated using a homemade software based on the differential method [3]. The structure considered as the reference one has grating period $\Gamma = 800$ µm, grooves depth p = 200 µm, and has been characterized under incident angle $\theta = 10°$. These values have been chosen to obtain a sufficient number of m-lines in the THz signature from 200 GHz to 800 GHz.

Results:

Authentication process is based on the possibility to discriminate two slightly different THz signatures: 1) the reference structure described above and 2) a structure whose parameters have been slightly modified. For that purpose, we calculate correlation coefficient (CC) of both signatures. The results of the authentication process are presented in Fig. 1.b. To enlighten the sensitivity of the THz signature relatively to the variation of the grating depth, we calculate the CC on the transmission (green line and dots) and on the second derivative (blue line and dots) of structures whose grating depth differs from the reference one over a range of 100 µm. According to Fig. 1.b, CCs calculated from 2^{nd} derivatives of the spectral signatures is dedicated to authentication purpose since it drops steeply to 0 with depth variation of grooves of only tens of µm.

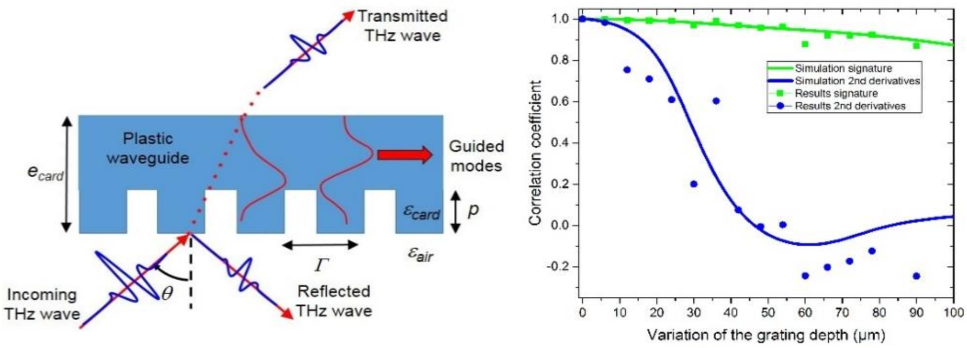

Fig. 1 (a) Transversal scheme of the proposed structure dedicated to smart cards authentication. (b) CCs calculated on the signatures and its second derivatives versus the variation of the grating depth p.

Conclusion: In this study, we showed the possibility to authenticate smart cards in the THz domain using a diffractive grating structure directly engraved on the devices. To authenticate such structures, we used the correlation coefficient as a very sensitive authenticator when calculated on the 2^{nd} derivatives of the THz signature. We also show that a change of the geometrical size of the grating as small of several µm lead to a significant and sufficient modification of the THz signature to be used in authentication process with the objective to oppose counterfeiting.

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References

[1] Roux, J.-F., Aquistapace, F., Garet, F., Duvillaret, L., Coutaz, J.-L., "Grating-assisted coupling of terahertz waves into a dielectric waveguide studied by terahertz time-domain spectroscopy', *Appl. Opt.*, 41 (2002)

[2] Roux, J.-F., Aquistapace, F., Garet, F., Duvillaret, L., Coutaz, J.-L., 'High efficiency coupling of THz pulse radiation into a dielectric waveguide', *Elec. Lett.*, 37 (2001)

[3] Vincent, P., "Differential methods", In *Electromagnetic Theory of Gratings*, Springer Berlin Heidelberg (1980)