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Design of a terahertz CW photomixer based on PIN and superlattice PIN devices

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Abstract—We present the design of a photomixer LO based on standard and superlattice PIN diodes, operating at 1 THz. The design is based on a direct integration of a double slot antenna with the PIN device and a suitable matching circuit. The antenna has been designed together with a dielectric lens using Ansoft HFSS EM simulation. The large-signal PIN diode model employed in the work has been improved compared to our previously developed model presented earlier in a 3 THz design. We demonstrate that the antenna characteristic changes drastically with the device in place.

I. INTRODUCTION

We consider simulation experiments of photomixers for LO THz signal generation using PIN structures. PIN type devices, such as the UTC device have demonstrated good high frequency performance and higher output powers as compared to the LT GaAs mixers at THz frequencies. In this paper we concentrate on the integration issues of such devices with both broadband and resonant antenna structures. Our study is based on 3-D EM simulation and large-signal device simulation [1], [2].

II. INTEGRATED PHOTOMIXER ANTENNA STRUCTURES

The devices employed in the study were generic PIN diodes or the recently introduced NIPNIP superlattice photomixer devices. The large-signal model of these devices has been implemented into a circuit simulator using VHDL-A. The device structure is provided in fig.1 integrated with a resonant antenna. The simulations without device show a good radiation pattern with a radiation efficiency around 93% using a Au metal thickness of 0.5µm and a 7.7 dB larger main beam compared to backside radiation. At 1 THz the antenna gain is 7.5 dB.

Introducing the device simulations show a tilted main beam angle of about 10 degrees, as indicated in fig.2 (left). The back lobe radiation is still low compared to the main beam radiation, but the backside radiation decreases to 6.6 dB. The antenna gain is 5.73 dB. The decreased antenna efficiency is due to the mismatch between the device impedance and antenna structure impedance.

III. CONCLUSIONS

A design study of a THz photomixer has been demonstrated. The emphasis in the paper is on the integration of the photomixer device with a resonant antenna. It is shown that due to the large device geometry and performance of the integrated antenna is deteriorating considerably.

REFERENCES
