# Active Modulation of Terahertz Wavefront

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***Abstract*—Terahertz (THz) radiation has attracted a lot of attentions due to its fascinating potential applications. Wavefront modulation of the THz radiation will benefit the applications of THz imaging and communication. We propose a novel approach to actively modulate the wave-front of the THz radiation based on the THz hologram formed with photon-generated carriers. The diffracted THz beam will come into special amplitude and phase distribution. Experiment results demonstrate the validity of this new method.**

## I. INTRODUCTION

Terahertz (THz) imaging is one of most important applications of the THz radiation which can be commercialized quickly. Modulation of THz wavefront will benefit the applications of THz imaging and communication for acheriving high resolution, good signal noise ratio, and far communication distance. We adopt the photon-generated carriers to form THz holograms on the surface of a semiconductor surface, which can diffract the THz to generate the desired amplitude and phase distribution.

## II. RESULTS

Under the illumination of a strong light which photon energy is larger than the band gap, the semiconductor will generate free carriers on its surface. These free carriers can effectively block the transmission of the THz radiation. The diffusion range of the photon-generated carriers is just few micrometers, which is much less than the wavelength of the THz radiation. Therefore, we can project a computer generated hologram (CGH) pattern on the surface of the semiconductor to generate a photo-generated carriers based THz hologram. The diffracted beam will from the special amplitude and phase distribution.

A 500 um thick silicon wafer is used to generate the active hologram with the pulse light from a 800 nm amplifier. The THz radiation is generated with a ZnTe crystal and is detected with another ZnTe crystal. A spatial light modulator (Holoeye LC2002, resolution 800*600, pixel size 32 um) is adopted to excite the carrier distribution of the designed THz CGHs on the silicon surface. In order to achieve better results, an off-line holography configuration is adopted. The THz radiation is reflected onto the silicon wafer with an incident angle of 37 degrees. Three letters ‘‘C’’, ‘‘N’’ and ‘‘U’’ are required to be shown on the plane which is 2 cm away from the silicon wafer. The size of each letter is about 4 mm  6 mm. The calculated CGHs are displayed on the optical SLM and projected onto the surface of the silicon wafer, respectively. The complex amplitude distribution of the THz beam on the observation plane is captured with the THz focal plane imaging system. As shown in Fig. 1, the three letters ‘‘C’’, ‘‘N’’ and ‘‘U’’ are clearly reconstructed. The experimental results meet the theoretical expectations quite well.

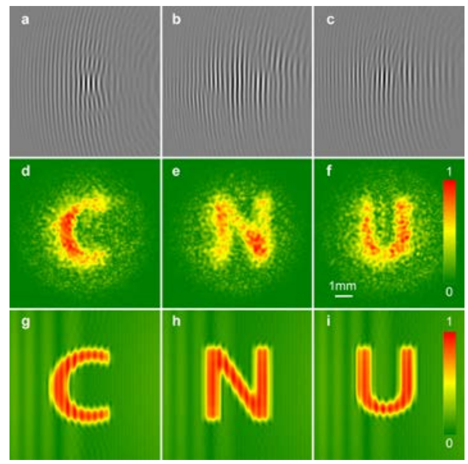


Fig. 1 Special field distributions generated with the active THz wavefront modulator. a-c, Off-axis THz computer-generated holograms for letters C, N and U. d-f, THz intensity distributions on the observation plane. g-i, Theoretical expectations of the THz intensity distributions on the preset plane for letters C, N and U, respectively.

## III. SUMMARY

In conclusion, a scheme for generating arbitrary THz wavefront is proposed. The amplitude and phase distributions of the THz beam are dynamically regulated by the THz CGH pattern formed with the photo-generated carriers. The experimental results, which correspond to the theoretical expectations well, demonstrated the effectiveness and validity of the proposed method. The proposed method may benefit to the THz sensing, THz imaging, and THz communication.

## REFERENCES

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