Carrier Conversion From Terahertz Wave To Dual-Wavelength Near-Infrared Light Injection-Locked Optical Comb For Photonic Terahertz Detection In Wireless Communication

Y. Matsumura(1), Y. Tokizane(1), E. Hase(1), N. Kuse(1), T. Minamikawa(1,2), J. Fujikata(1), H. Kishikawa(1), M. Haraguchi(1), Y. Okamura(1,3), T. Kaji(4), A. Otomo(4), I. Morohashi(4), A. Kanno(4,5), S. Hisatake(6), and T. Yasui(1)

(1) Tokushima Univ., Tokushima 770-8506, Japan, (2) Osaka Univ., Osaka 560-8531, Japan, (3) Univ. Yamanashi, Yamanashi 400-8510, Japan, (4) NICT, Tokyo 184-8795, Japan, (5) Nagoya Inst. Technol., Aichi 466-8555, Japan, (6) Gifu Univ., Gifu 501-1193, Japan; e-mail: yasui.takeshi@tokushima-u.ac.jp

This study explores the potential of utilizing Terahertz (THz) waves as wireless carriers in next-generation mobile communications (6G). The objective is to achieve "photonic THz detection" by converting THz carrier into optical carriers compatible with existing optical communication platforms [1]. The proposed method involves using an electro-optic polymer (EOP) modulator [2] in conjunction with an electro-optic modulator optical comb (EOM comb) [3].

The principle of operation involves injection-locking a pair of high-power continuous-wave (CW) lasers to two adjacent modes of the EOM comb. This injection-locked optical carrier is then propagated through an optical waveguide to the EOP modulator, where a THz wave serves as an external electric field for phase modulation. The resulting modulation sidebands are separated from the unmodulated optical carrier by the THz frequency. Heterodyne detection of the optical beat between these sidebands is used to measure the radio-frequency (RF) beat signal [4].

The experimental setup utilizes an EOM comb with a frequency spacing (f_{rep}) of 10 GHz. The pair of high-power CW lasers, when injection-locked to two EOM-comb modes with a frequency separation of 10 f_{rep}, produces stable RF beat signals. These signals are observed around 1 GHz when a 101-GHz THz wave is applied to the EOP modulator. The achieved signal-to-noise ratio (SNR) of 25 dB is deemed sufficient for wireless communication.

In summary, the study demonstrates successful photonic THz detection using a 101-GHz THz wave, facilitated by THz-to-optical carrier conversion with an EOP modulator and injection-locked dual-wavelength optical carriers. This approach holds promise for the practical implementation of THz-based wireless communication systems.

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