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# 375-GHz-Band Antenna-Coupled Optical Modulators Using Electro-Optic Polymer Waveguides and Non-Coplanar Patch Antennas

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Towards the realization of 6G and future wireless communication systems, the radio-over-fiber (RoF) technology that transmits signal waveforms of terahertz waves (0.1-10 THz) using optical fibers is attracting much attention. To realize the receivers in the radio section of the mobile fronthaul/backhaul in the RoF systems, it is necessary to develop devices that convert THz signals into optical signals. Organic electro-optic (EO) polymers can have large EO coefficients ($r_{33}$ > ~100 pm/V) and the figure of merit ($n^3r_{33}$) for optical modulation compared with lithium niobate. In addition, the EO polymers have relatively small absorption coefficients in the terahertz region, and the difference in refractive index between optical region and terahertz region is small. These features make it possible to develop optical modulators that operate at hundreds of GHz or higher. To develop high-performance optical devices operating in the terahertz region, we have developed a method of transferring and bonding an EO polymer film that has been poled in advance onto a substrate, making it possible to fabricate the devices in which the EO polymer film and terahertz wave low absorption loss materials such as cyclo-olefin polymers (COPs) were combined [1]. By using this method, we fabricated D-band (110–170 GHz) antenna-coupled optical modulators using EO polymer waveguides and nonplanar patch antennas [2]. In this study, we fabricated and evaluated 375-GHz-band antenna-coupled optical modulators using the EO polymer waveguides and nonplanar patch antennas with the aim of further improving the operating frequency (Fig. 1(a)). Figure 1(b) shows the optical spectrum of output light from the device under irradiation of 375 GHz electromagnetic waves. We observed optical sidebands with a carrier-to-sideband ratio (CSR) of 47 dB corresponding to an optical phase shift of 8.8 mrad with an irradiation power density of 290 W/m$^2$ and demonstrated direct optical modulation by 375 GHz electromagnetic wave irradiation. We also plan to report on the details of our study toward the application of the device to wireless communication experiments.

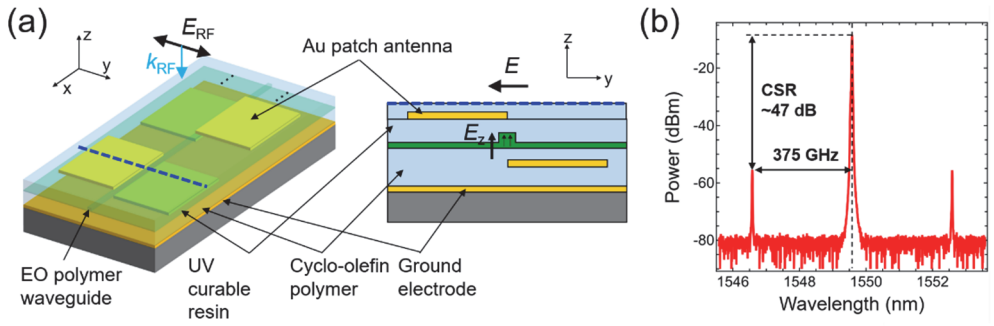


**Figure 1.** (a) Schematic diagram of an optical modulator using an electro-optic (EO) polymer waveguide and non-coplanar patch antennas. (b) Optical spectrum of output light from the device under irradiation of 375 GHz electromagnetic waves

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**References**

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