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Single-chip for Terahertz Emission and Detection on Thin-film Lithium Niobate Platform

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The terahertz (THz) frequency region (0.1-10 THz) between microwaves and infrared, holds significant potential across various fields such as communication, sensing, and spectroscopy. Conventional THz systems for broadband emission and detection remain bulky and complex, making the development of a fully integrated, miniaturized THz system on a chip a significant challenge. Lithium niobate is an excellent material for THz emission and THz detection for its high second order nonlinearity and low optical losses in the near-infrared range [1]. Recently, thin-film lithium niobate (TFLN) platform has shown great potential for integrated THz systems [2-4]. Here, we develop a single device with dual functionalities based on the TFLN platform, capable of both THz emission and detection. Operating at the zero-dispersion wavelength (~ 1310 nm) for conventional single mode fiber, the system maintains short pulse duration without the requirement for complicated dispersion compensation methods, enabling broadband THz emission and detection from 0.1 to 2.5 THz.

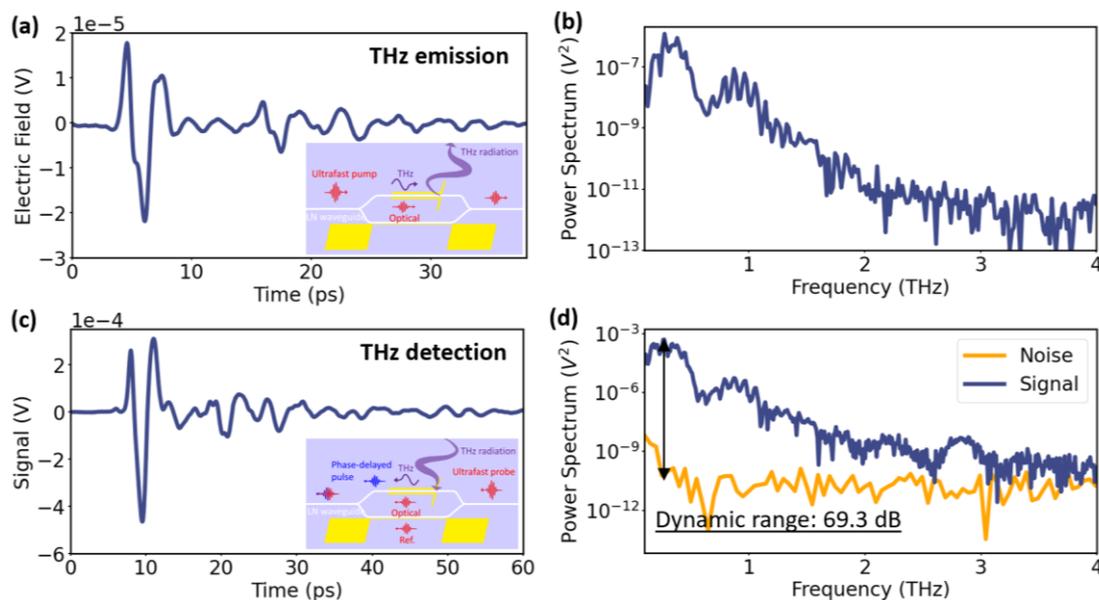


Fig. 1. (a) Time trace and (b) spectrum of generated THz signal from TFLN chip. (c) Time trace and (d) spectrum of detected THz signal on TFLN chip (with noise spectrum and dynamic range).

Fig. 1(a) and Fig. 1(b) display the measured time trace and spectrum of the THz signal generated by the TFLN chip, with the PCA as the detector. The inset figure in Fig. 1(a) shows the schematics of the single-chip THz emission. Fig. 1(c) and Fig. 1(d) show the time trace and power spectrum of the THz signal detected by the TFLN chip, with the PCA as the emitter. The inset figure in Fig. 1(a) shows the schematics of the single-chip THz detection.

In conclusion, we realize a dual-function integrated THz emitter-detector chip on TFLN platform capable of broadband THz emission and detection (0.1-2.5 THz) from the same device. Our device is fully compatible with commercial fiber technologies thanks to operating at 1310 nm wavelength, thereby eliminating the complexities associated with dispersion compensation.

References

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