

# Development of a terahertz pump and electron diffraction probe setup for the dynamics measurements of liquid crystals

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Terahertz (THz) wave is electromagnetic at wavelengths of 0.1–10 THz. High-intensity THz pulse (~1 MV/cm) can be generated using the tilted-pump-pulse-front scheme that converts a femtosecond laser pulse into a THz pulse on a LiNbO<sub>3</sub> crystal.[1] THz wave can be used as electric field pulses that oscillate at ~1 ps. Ultrafast electron diffraction is a method of directly probing atomic and molecular motions in samples in the excited state. Namely, it is possible to observe changes in atomic and molecular motions occurring in the samples under an electric field by performing ultrafast electron diffraction using a THz pulse as excitation light. Liquid-crystalline molecules are widely used in optical devices and displays, where their motions connect to the functions of the devices. Thus, it is crucial to understand the dynamics in the liquid-crystalline molecules under an electric field; however, there is no report on the elementary process of liquid-crystalline molecule motion under electric field. It remains unclear whether electric field-induced picosecond response occurs in liquid crystals. We are developing a THz pump and electron diffraction probe setup to observe the ultrafast molecular motions in the liquid crystal under a THz electric field pulse.

The electron pulse duration was evaluated from the interaction between the THz pulse and the electron pulse. In ultrafast electron diffraction experiments, it is important to measure the duration of the electron pulse because the duration determines the time resolution. We estimate the electron pulse duration by bending the trajectory of the electron pulse by the electric field of the THz pulse.[2] We developed a THz generation system, a THz characterization system, an electron pulse generation system, and a THz streaking system with a resonator. As a

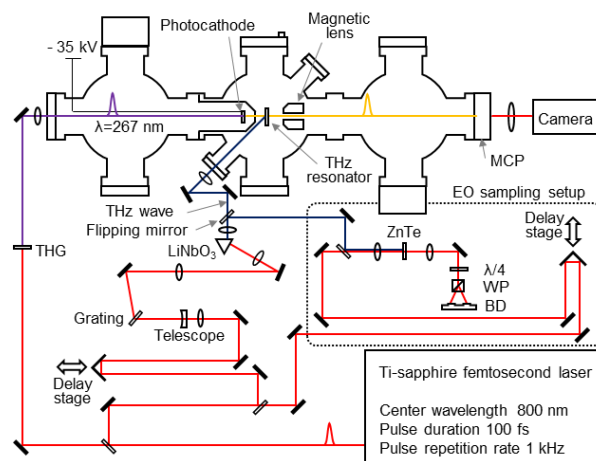


Fig. 1 Experimental setup

result, the electric field of the THz wave incident on the resonator was determined to be 2.6 kV/cm, and the electron pulse duration was estimated to be ~5 ps. In the future, we will develop the setup for performing ultrafast structural dynamics measurements under a THz electric field.

## References

- [1] H. Hirori, et al., Appl. Phys. Lett. 98, 091106 (2011).
- [2] C. Kealhofer, et al., Science 352, 429-433 (2016).