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Development of Ultrafast Time-resolved Electron Diffraction Setups and Their Applications

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Methods have been developed to observe the light-driven atomic motions of molecules and materials on the ultrafast timescale of 10^{-14} to 10^{-12} (femto-to-picoseconds). This progress reveals the mechanisms of photoreactions and photoinduced phase transition phenomena in molecules and materials. [1,2]. Ultrafast time-resolved electron diffraction employs diffraction techniques to directly measure the photoinduced changes of atomic or molecular coordinates. In this presentation, I will discuss the progress of the developments of ultrafast time-resolved electron diffraction setups, *i.e.*, the conventional picosecond time-resolved electron diffraction setup, picosecond time-resolved electron diffraction setup with a high coherence electron probe, and femtosecond time-resolved electron diffraction setup with a synchronized radio frequency (RF) cavity [3]. **FIGURE 1** shows the photographs of the setups. The schematic illustration of the setup with an RF cavity is shown in **FIGURE 2**.

The presentation will also show the measurements of ultrafast structural dynamics of molecules and materials using ultrafast time-resolved electron diffraction setups. These measurements are combined investigation of ultrafast time-resolved electron diffraction measurements, ultrafast transient absorption measurements, and first-principles calculations. One of the topics is a recently published study about a one-dimensional van der Waals heterostructure [4]. The heterostructure contains carbon nanotubes (CNTs) as an inner core and boron nitride nanotubes (BNNTs) as an outer core. We found peculiar charge transfer channels between CNTs and BNNTs through the heterostructures. At the same time, I would like to introduce the photoinduced structural dynamics in a semiconducting solar cell material [5] and photo-responsive organic molecules [6].

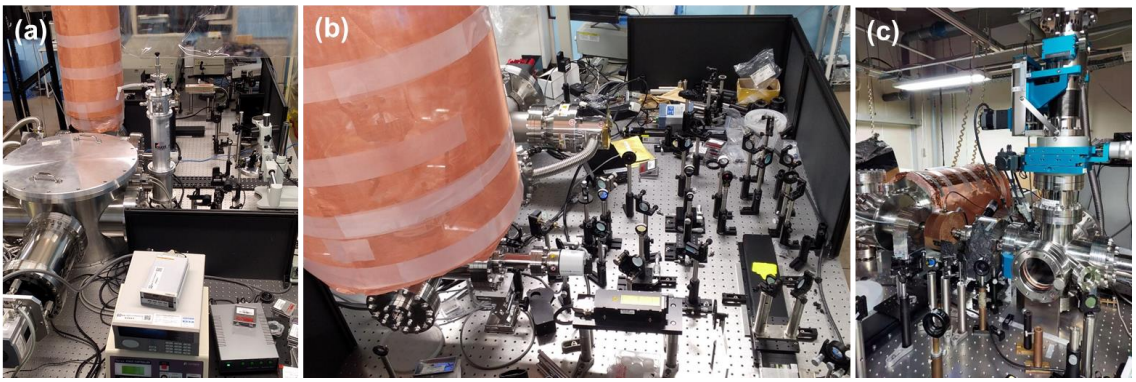

FIGURE 1. Photographs of the developed time-resolved electron diffraction setups. The conventional picosecond time-resolved electron diffraction setup (a), picosecond time-resolved electron diffraction setup with a high coherence electron probe (b), and femtosecond time-resolved electron diffraction setup with a synchronized radio frequency (RF) cavity (c).

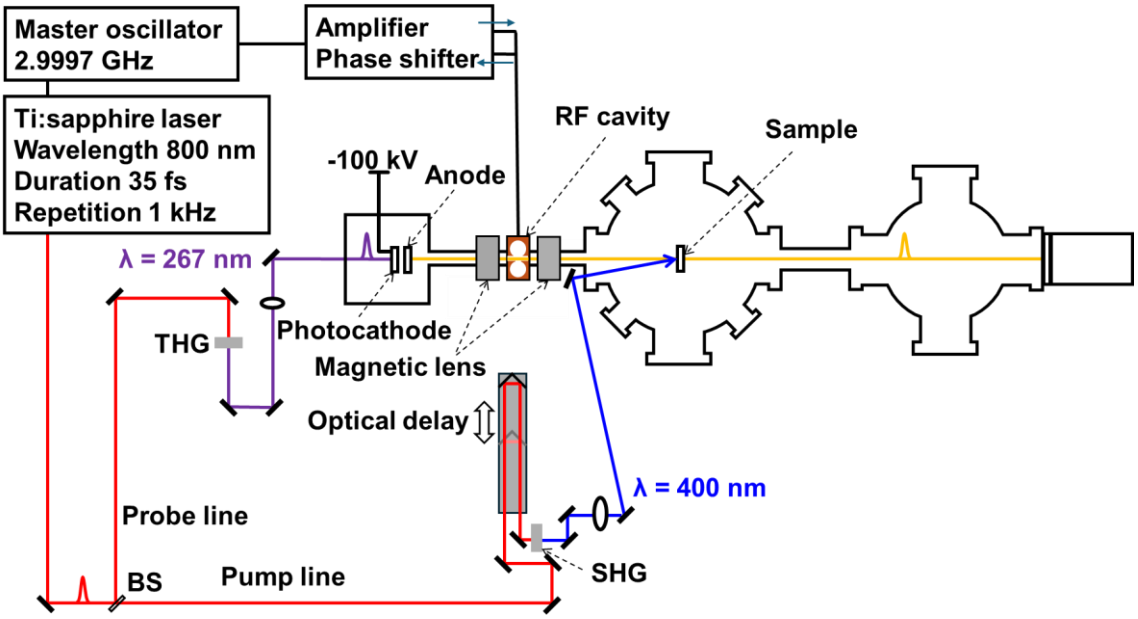

FIGURE 2. The schematics of the setup with an RF cavity

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