Research topics for graduate students for 2023

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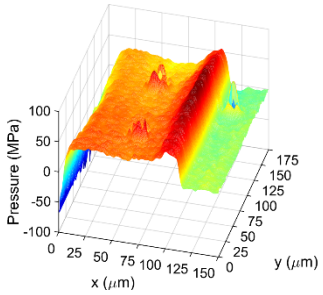
Acceptable course(s)

- Master's Degree
- Doctoral Degree

Research Topics



Our group is developing **ultrafast measurement and control methods for material properties** under irradiation of intense light (femtosecond laser), and is aiming to create innovative processing technologies based on these methods. When materials are irradiated by femtosecond lasers, various physical phenomena appear on various time scales. We are developing ultrafast (picosecond to nanosecond) measurement methods that enable us to not only observe but also quantitatively measure the phenomena that occur on each time scale [1]. Furthermore, we are developing innovative processing technology by utilizing the physical phenomena revealed by ultrafast measurement. We have achieved hole drilling 5,000 times faster than conventional methods by transiently controlling physical properties [2]. In addition, by spatially controlling the excitation region, large-scale machining such as internal machining and grooving has been achieved at a factor of 500 times faster than conventional machining. If you are interested in either machining, physics, or metrology, we encourage you to apply. No prior expertise is required.

1. Ultrafast laser processing of semiconductors

We have shown that transient metallization (electronic excitation) of transparent materials enables processing 5,000 times faster than conventional methods [2], but this metallization technique is only applicable to transparent materials. The next step of our research is to realize ultrafast processing of semiconductors, which are opaque, by establishing a technique for ultrafast measurement and control of electron density.

2. Ultrafast imaging of electron-phonon interaction

When a transparent material is irradiated by a femtosecond laser pulse, electrons are excited on a time scale of less than picoseconds, and electron-phonon interactions begin at around 10 ps. We are developing an imaging system and simulation to capture the ultrafast physics of this electron-phonon interaction process, and clarify the physics in the early stage of the excitation.

Articles Related to Research Topics

[1] Y. Ito et al., Interferometric and fluorescence analysis of shock wave effects on cell membrane, *Communications Physics* 3, 124 (2020).

[2] Y. Ito et al., Ultrafast and precision drilling of glass by selective absorption of fiber-laser pulse into femtosecond-laser-induced filament, *Applied Physics Letters* 113(6), 061101 (2018).

Lab. Web page: https://www.mfg.t.u-tokyo.ac.jp/?page_id=141&lang=en