Development of a compact spectrometry system for femtosecond luminescence and studies on luminescence phenomena in metals

Tohru Suemoto (Fellow)
Toyota Physical and Chemical Research Institute

Purpose

The ultrafast spectroscopy, which reveals ultrafast phenomena below picosecond regime, made remarkable progress in these three decades. However, the experiment requires special technique, which is not so familiar to the researchers of material science. The up-conversion luminescence spectroscopy is a very powerful method having a time resolution as high as 40 fs for visible light and a high sensitivity in the infrared (IR) up to 5 microns in wavelength. Unfortunately, however, this method is not popular even for the researchers working in the field of spectroscopy because of technical difficulties. In order to promote the field of ultrafast IR luminescence, I decided to develop a compact, stable and user-friendly femtosecond luminescence spectrometer, which does not require specialized technique of ultrafast spectroscopy. By using this spectrometer, which will have high performance, the luminescence phenomena in semi-metals and metals, which have not been studied systematically in the past, will be investigated.

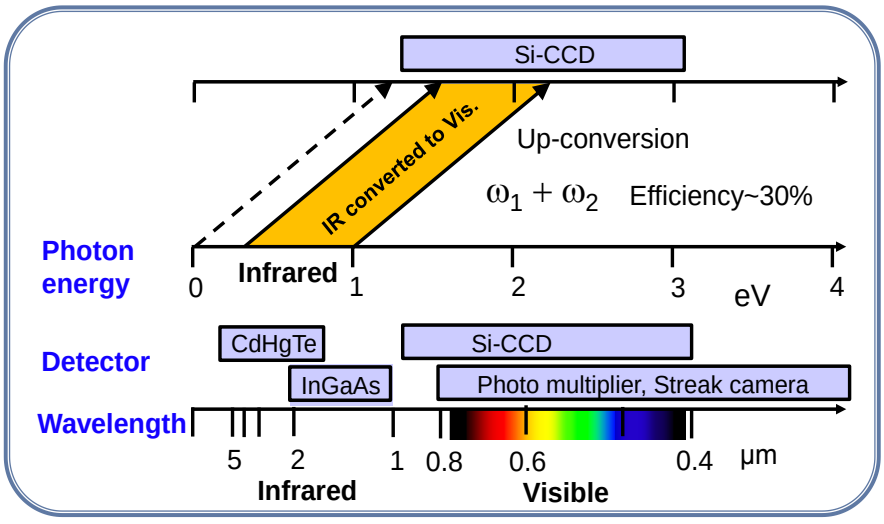

Fig. 1 By using so-called "up-conversion" technique, we can perform time-resolved measurement with femtosecond time resolution. As the infrared photons are converted into visible photons through sum frequency generation process, we can use CCD camera or photomultiplier for detection and realize very high sensitivity.

Methods

Instead of the traditional mode-locked titanium sapphire laser, I use an ytterbium fiber

laser as a femtosecond pulse source. This will make the system very compact and stable, enabling a long-time experiment. Based on the knowledge accumulated during my research career at the university, high performance user-friendly compact up-conversion spectrometer will be designed and constructed.

Expected achievement and applications

High sensitivity and long-time accumulation will allow us observation of very weak luminescence for example that from metals. Time resolved luminescence spectroscopy in infrared region will provide new methodology for investigating light emitting devices, thermoelectric materials, biomaterials and so on.