Bases for time-resolved probing of transient carrier dynamics by optical pump-probe scanning tunneling microscopy

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To explore ultrafast dynamics on the nanoscale, we have developed a new microscopy technique, i.e., STM combined with optical pump-probe method. In the new STM technique, the sample below the STM tip is illuminated by a sequence of optical pump and probe pulses and the change in tunneling current is measured as a function of delay time between the two pulses. By applying this technique, fundamental carrier dynamics in semiconductors, such as direct carrier recombination, drift-diffusion and carrier capture dynamics have been successfully observed [1,2]. However, physical mechanism producing SPPX-STM spectra (Fig.1) has not yet been fully understood. In this study, we have analyzed the tangled mechanism with the simulations based on the evolution of surface photovoltage (Fig.2). The optimum conditions required to realize reliable measurement, as well as the validity of the microscopy technique, which were clarified for the first time, will be discussed in detail at the conference.

[1] Nat. Photonics, 2010, 4, 869. [2] Appl. Phys. Exp., 2013, 6, 032410.

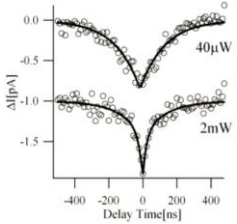

Fig.1: Time-resolved spectra of GaAs under different laser intensities.

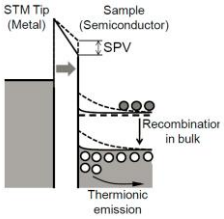

Fig.2: Band diagram of STM tunnel junction