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## Femtosecond time-resolved scanning tunneling microscopy and its applications

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Smaller and faster have been the keywords in nanoscale science and technology. Therefore, development of a method for exploring the ultrafast transient dynamics in small organized structures with high spatial resolution is a key factor for further advances in current science and technology. Scanning tunneling microscopy (STM) is one of the most promising techniques for the analysis of such properties because of its high spatial resolution. However, since its temporal resolution is low, the addition of high temporal resolution to STM and related techniques has been an attractive target since its invention. We have been developing a microscopy technique that simultaneously realizes the spatial resolution of STM and the temporal resolution of ultrashort-pulse laser technology, optical pump-probe (OPP) method. The combination of STM with optical technology has advantages to enable the analysis of photo-induced dynamics on the nanoscale. In OPP-STM, a non-equilibrium carrier distribution is generated using ultrashort laser pulses and its relaxation processes are probed by STM using the OPP method realized in STM. By combining the microscopy with atom tracking technique, even a single-atomic-level analysis of the carrier dynamics has become possible. With the development of a new modulation technique of circularly polarized light, detection of spin dynamics has been realized. Details will be discussed with the recent results at the conference.

1. Y. Terada, S. Yoshida, O. Takeuchi, and H. Shigekawa: *Nat. Photonics* 4 (2010) 869.
2. Y. Terada, S. Yoshida, O. Takeuchi, and H. Shigekawa: *J. Phys.: Condensed Matter* 22 (2010) 264008.
3. S. Yoshida, Y. Terada, O. Takeuchi, and H. Shigekawa: *Nanoscale* 4 (2012) 757.
4. S. Yoshida, M. Yokota, O. Takeuchi, Y. Mera, and H. Shigekawa: *Appl. Phys. Exp.* 6, (2013) 016601.
5. S. Yoshida, M. Yokota, O. Takeuchi, H. Oigawa, Y. Mera, and H. Shigekawa: *Appl. Phys. Exp.* 6, (2013) 032401.
6. S. Yoshida, Y. Terada, M. Yokota, O. Takeuchi, H. Oigawa, and H. Shigekawa: *The European Physical Journal Special Topics* 222, 1161-1175 (2013).
7. S. Yoshida, Y. Aizawa, Z. Wang, Y. Mera, H. Oigawa, O. Takeuchi, and H. Shigekawa: *Nat. Nanotechnology*, 9, 588-593 (2014).
8. H. Shigekawa, S. Yoshida, and O. Takeuchi, *Nat. Photonics* 8 (2014) 815.