Femtosecond time-resolved STM and its application to the analysis of ultrafast dynamics in the nanoscale world

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"Smaller" and "Faster" are the main concepts in nanoscale science and technology. Indeed, important and interesting phenomena in various systems, such as functional materials, electronic devices, signal transfer in biosystems, and chemical reactions, are observed from the several tens of nanometers to the single-molecule range in space and from the several tens of picoseconds to subpicosecond range in time. However, with the size reduction in structures, the difference in the electronic properties, for example, caused by the structural nonuniformity in each element, has an ever more crucial influence on macroscopic functions. And the direct observation of the characteristics, which provides us with the basis for the macroscopic analysis of the results, is of great importance. Although, for further advances, a method of exploring the transient dynamics of the local quantum functions in organized small structures is eagerly desired, it is extremely difficult to obtain spatial and temporal resolutions simultaneously on this scale. Therefore, it is necessary to develop a new method, namely, new microscopy.

I would like to introduce our researches and efforts on the laser-combined STM and related techniques recently we have developed, with some latest results obtained based on them.

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[1] O. Takeuchi, M. Aoyama, R. Oshima, Y. Okada, H. Oigawa, N. Sano, R. Morita, M. Yamashita, and H. Shigekawa, Appl. Phys. Lett. 85(15), 3268 (2004).

[2] O. Takeuchi, S. Yoshida and H. Shigekawa, Appl. Phys. Lett. 84(18), 3645 (2004).

[3] H. Shigekawa, O. Takeuchi and M. Aoyama, Sci. & Technol. of Advanced Materials, 6, 582 (2005).

[4] Mono-Cycle Photonics and Optical Scanning Tunneling Microscopy -Route to Femtosecond Angstrom Technology-, Springer (2005), ed. by M. Yamashita, H. Shigekawa and R. Morita.

[5] Y. Terada, M Aoyama, H. Kondo, A. Taninaka, O. Takeuchi, H. Shigekawa Nanotechnology 18, 044028 (2006).

[6] S. Yoshida, Y. Kanitani, R. Oshima, Y. Okada, O. Takeuchi, H. Shigekawa, Phys. Rev. Lett. 98, 026802 (2007).

[7] S. Yoshida, Y. Kanitani, O. Takeuchi, and H. Shigekawa, Hyomen Kagaku, 28, 2, 111 (2007), in Japanese.

[8] H. Shigekawa, S. Yoshida, O. Takeuchi, M. Aoyama,Y. Terada, H. Kondo, H. Oigawa, Thin Solid Film, in print.

[9] S. Yasuda, T. Nakamura, M. Matsumoto and H. Shigekawa, J. Am. Chem. Soc., 125, 16430 (2003).