局所光励起及び検出のための極低温走査型プローブ顕微鏡の開発

Development of low-temperature scanning probe microscope for local optical excitation and probing

マックス・プランク協会フリッツ・ハーバー研究所 [1], 東工大理 [2] ○(D)吉野 紘子 [1,2], Shuyi Liu[1], Henrik Haak[1], Martin Wolf[1], 熊谷 崇 [1]

FHI of MPG [1], Tokyo Tech [2], °Hiroko Yoshino[1,2], Shuyi Liu[1], Henrik Haak[1], Martin Wolf[1], Takashi Kumagai[1]

E-mail: yoshino@fhi-berlin.mpg.de

Recently, control of the structures and physical properties of materials have reached the nanometer scale, and future device applications that offer unprecedented functions require the fine tuning at the atomic/molecular level. In the fabrication and characterization of materials, light plays a central role. However, conventional optical microscopy and spectroscopy have intrinsic limitations on the spatial resolution and cannot directly access local structure and properties below the diffraction limit. SPM techniques, such as scanning tunneling microscopy (STM) and atomic force microscopy (AFM), have the unique capability of imaging single atoms and molecules on surfaces and of conducting local spectroscopy at (sub-)nanometer spatial resolution. Usage of tNear-field opticsip-enhanced electric field, which is one of near field optics techniques, is more advantageous than conventional Raman spectroscopy because it allows us to achieve not only higher lateralnanoscale spatial resolution but also higher chemical sensitivity via the signal enhancemententhancement of local optical signals. The tip enhancement has been known as a surface plasmon polariton resonance through surface plasmon excitation at metallic probe apex of metallic nanostructures [1]. Therefore, a combination of SPM and light near-field optics is a promising approach of investigatingto investigate local light-matter coupling at the atomic/molecular level and potentially at ultrafast time resolution. For this purpose, several pioneering groups have demonstrated a combination of low-temperature SPM and lightwith optical excitation/detection [2, 3]. But However, they have a specialized design for the a specific purpose, which prevents flexible and efficient coupling of SPM to different types of light sources.

Our newly developed optical system supports enables highly efficient and flexible coupling of SPM and with light, which is represented attained by a parabolic mirror and a lens installed close to the STM junction (**Figure 1**). The SPM and *in-situ* optics system is cooled at the same temperature and multiple light sources are individually aligned and injected to SPM, which enables investigation of a broad range of light-induced physics and chemistry in SPM-scale spatial resolution. Multiple light beams can be precisely focused to about 3-um spot on the tip apex.

In this poster, we will show the experimental data and discuss the performance of the instrument as well as future applications.

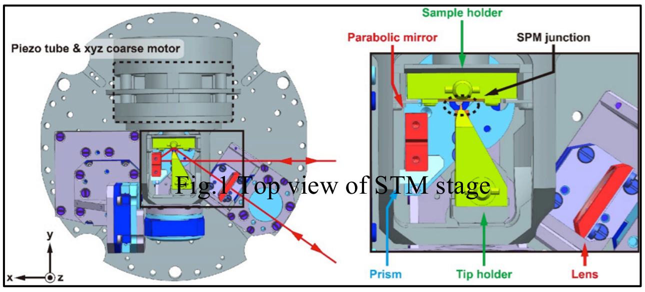

Fig.1 Top view of STM stage

References

[1] N. Hayazawa, Y. Inouye, Z. Sekkat, and S. Kawata, Opt. Commun. 183, 333 (2000).

[2] L. Bartels, F. Wang, D. Möller, E. Knoesel, T. F. Heinz, Science 305, 648 (2004).

[3] M. Mehlhorn, H. Gawronski, K. Morgenstern, Phys. Rev. Lett. 104, 076101 (2010).