

The Development of Femtosecond Time-resolved Scanning Tunneling Microscopy for Probing Ultrafast Coherent Phonon Dynamics

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The optically excited coherent phonon dynamics on semiconductor materials, has always been a hot issue both experimentally and theoretically. In this study, we developed an ultrafast laser combined Optical Pump-probe Scanning Tunneling Microscopy (OPP-STM) for the investigations of coherent phonon dynamics on GaAs, with both high temporal resolution (~ 50 fs) and spatial resolution (< 100 nm) on nanoscale.

The sample was GaAs (110) cleaved in UHV, femtosecond laser pulse trains were divided into two different optical paths, to be pump pulses and probe pulses, respectively. The coherent phonon oscillations can be induced by the pump pulse and then measured by the probe pulse due to the reflectance or absorbance changing originated from the optoelectronic effects, and the absorbance changing can be reflected in the tunneling current with varying the delay time between two laser pulses. Since this is the first time that the OPP-STM temporal resolution needs to be improved to < 200 fs in order to observe ultrafast phonon dynamics, laser pulse compression techniques as well as the newly designed mirror focusing system were applied. Thus, laser pulses were tightly focused on the sample under STM without compromising the pulse width. Basic experimental setting and part of the obtained results are shown in figure 1, the system design in detail and more results will be given in the poster presentation.

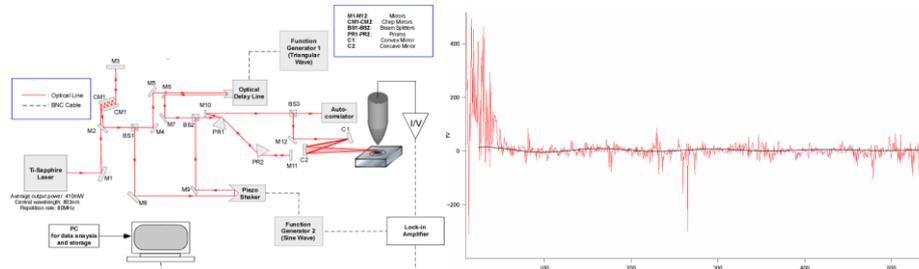


Fig.1. Left: The experimental setting of the OPP-STM. Right: The OPP-STM spectrum of coherent phonon oscillation on GaAs (110) surface.

References:

- [1]. O. Takeuchi et al., Probing sub-picosecond dynamics using pulsed laser combined scanning tunneling microscopy, *Appl. Phys. Lett.* Vol. 85(15), 3268-3270, 2004

