Spin Dynamics of GaAs Surface with Magnetic Adatoms Probed by Optical Pump-probe Scanning Tunneling Microscopy

Z.H. Wang[1, 2], C.H.Yoon[1], S. Yoshida[1], O. Takeuchi[1] and H. Shigekawa[1]
[1]Institute of Applied Physics, University of Tsukuba, Tsukuba, Ibaraki 305-8573, Japan
[2] Doctoral Research Fellow of Japanese Society of Promotion of Science (JSPS DC1)

Semiconductor spin dynamics has always been a research focus both theoretically and experimentally for many decades, as understanding quantum dynamical behaviors of electrons, holes, as well as nuclei in semiconductors are quite essential for further development on spintronics and quantum computation. Especially for diluted magnetic semiconductors (DMSs), in which some intriguing spin properties had been discovered compared to non-magnetic semiconductors[1], are considered to be of high potential in actual spintronics applications. Here we present a novel STM-based ultrafast measurement technique that our group has originally developed[2], to investigate spin dynamics of a cleaved GaAs [110] surface with manganese (Mn) adatoms. Empowered by this time-resolved Optical Pump-probe Scanning Tunneling Microscopy (OPP-STM) technique, we are able to observe ultrafast surface spin dynamics which are influenced by magnetic Mn impurities at nanoscale, exclusively with high temporal and spatial resolution at the same time.

Namely, our OPP-STM system combines the well-known optical pump-probe technique with STM, to dramatically enhance the temporal resolution of STM, while the spatial resolution is hardly being compromised. As shown in figure 1, with deposition controlling of Mn atoms on GaAs [110] surface, we have observed a changing in electron spin lifetime at room temperature, as it is predicted by Dyakonov-Perel spin relaxation mechanism[3]. Details of the experimental design as well as some other results will be introduced in the presentation. Moreover, recent progress on newly developed nuclear-spin-sensitive OPP-STM system, which might be enabling us to probe nuclear spin dynamics on nanoscale, will also be briefly reported.

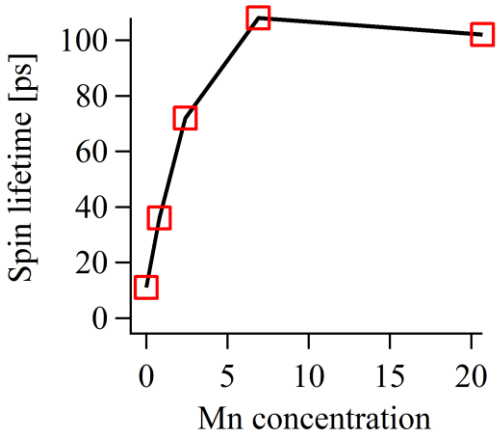

Figure 1. Electron spin lifetime variation with respect to Mn concentration on GaAs [110] surface

References:
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