Atomically thin semiconducting channels for future nano-electoronics

Kazuhito Tsukagoshi
WPI-MANA, NIMS
Tsukuba, Ibaraki 305-0047, Japan
TSUKAGOSHI.Kazuhito@nims.go.jp

Using atomic-scale thin film of metal chalcogenide layered material, we have developed semiconducting channel for future electronics. We investigated transport properties, particularly scattering property of carrier transport. In this transport experiment, it is found that the carrier scattering from interfacial Coulomb impurities is greatly intensified in extremely thinned channels, resulting from shortened interaction distance between impurities and carriers.

Thus, we fabricated MoS_2 field-effect transistors on crystalline hexagonal boron nitride (h-BN) and SiO_2 substrates. Temperature dependence of these transistors shows distinct weak temperature dependence of the MoS_2 devices on h-BN substrate. At the room temperature, mobility enhancement and reduced interface trap density of the single and bilayer MoS_2 devices on h-BN substrate further indicate that reducing substrate traps is crucial for enhancing the mobility in atomically thin MoS_2 devices. More detail of carrier scattering in the atomic-scale thin channel will be discussed.

Furthermore, we have developed field effect transistor using high-k flak dielectric with layered structure.

Acknowledgments

We like to thank Dr.H.Miyazaki, Dr.Songlin Li, Dr. A.A.Ferreira, Dr. M.-Y. Chan, Dr.W.Li, Dr.Y.-F.Lin, Dr.S.Nakaharai, Dr.K.Wakabayashi, Dr.M.Osada, Dr.T.Sasaki and Prof.K.Ueno for the collaboration to proceed this research. This work was supported in part by the FIRST Program from the Japan Society for the Promotion of Science and JSPS- KAKENHI Grant Number 25107004.

References

[1] S.-L. Li, K.Wakabayashi, Y.Xu, Y.-F.Lin. M.Y.Chen, K.Komatsu, S.Nakaharai, A.Aparecido-Ferreira, W.W. Li, K.Tsukagoshi, Nano Letters 13, 3546 (2013).
[2] M.-Y. Chan, K. Komatsu, S.-L.Li, Y.Xu, P.Darmawan, H.Koramochi, S.Nakaharai, K.Watanabe, T.Taniguchi, K.Tsukagoshi, Nanoscale, in press (2013).
[3] W.-W. Li, S.-L.Li, K.Komatsu, A.A. Ferreira, Y.-F. Lin, Y.Xu, M.Osada, T.Sasaki, K.Tsukagoshi, Applied Physics Letters 103, 023113 (2013).