Electric-Field Thermopower Modulation Method

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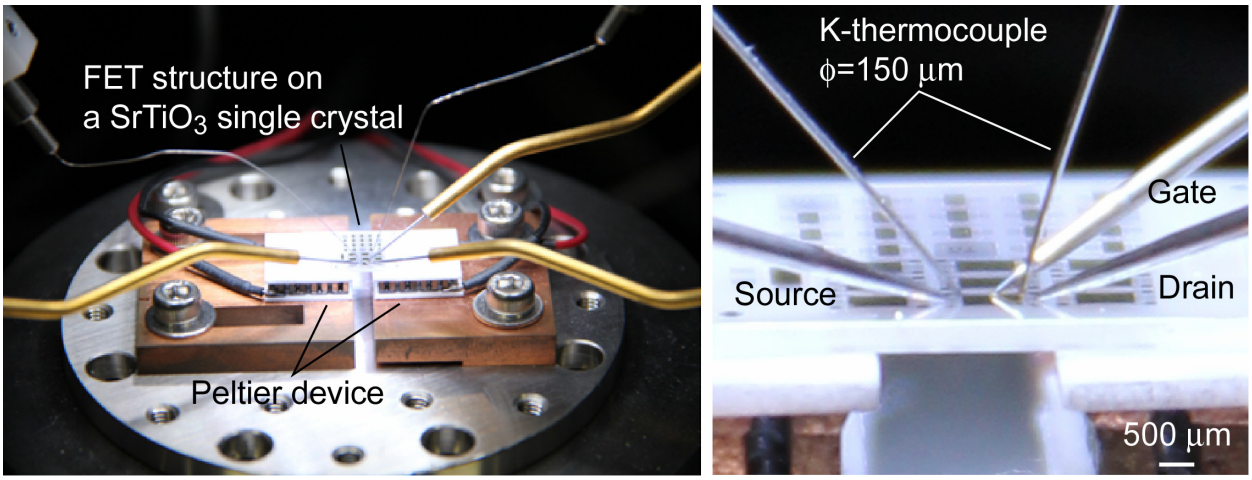

I demonstrate herein that an electric field induced 2DEG provides unusually large enhancement of thermopower (S).[1] Field effect transistor structures were fabricated on a $SrTiO_3$ single crystal plate using water infiltrated nanoporous glass (CAN) as a gate insulator.[2] The CAN gate insulator can accumulate carrier electrons up to ~10^{15} cm^{-2}, which is two orders of magnitude higher than that can be accumulated by conventional gate insulator such as SiO_2, Al_2O_3 and dry C12A7.[3] The thermopower S values were measured by steady state method using the homemade equipment (Fig.) at room temperature. $|S|$ initially decreases with n_{sheet} from ~1150 to ~250 μV K^{-1}. Simultaneously, effective thickness of the 2DEG (t_{eff}) decreases from ~100 to ~2 nm. In this region, the n_{sheet} dependence of $|S|$ is similar to that of simulated bulk values. When the n_{sheet} value exceeds ~2.5×10^{14} cm^{-2}, $|S|$ increases drastically and is modulated from ~600 (n_{sheet} ~2×10^{15} cm^{-2}) to ~950 μV K^{-1} (n_{sheet} ~8×10^{14} cm^{-2}), while t_{eff} remains nearly constant (~2 nm). $|S|$ vs. log n_{sheet} relation is approximately five times larger than that of the bulk, clearly indicating that the electric field induced 2DEG in $SrTiO_3$ exhibits an unusually large $|S|$. Moreover, because the present electric field thermopower modulation method is simple and effectively verifies the performance of thermoelectric materials, it may accelerate the development of nanostructures for high performance thermoelectric materials.

References

[1] H. Ohta *et al*., *Adv. Mater.* **24**, 740 (2012). [2] H. Ohta *et al*., *Nature Commun*. **1**, 118 (2010). [3] H. Ohta *et al*., *Appl. Phys. Lett.* **95**, 113505 (2009).