# Substrate Engineered thermoelectric junction of single 2D material

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Abstract

A junction of two materials with different Seebeck coefficients generates thermoelectric power when it is heated. Some 2D semiconductors are attractive for thermoelectric applications thanks to their large and controllable Seebeck coefficients [1]. Tuning the Seebeck coefficient of 2D materials is nevertheless non-trivial and often relies on controlled doping and engineering the electron-phonon scattering mechanisms [2]. In this study, we exploit the substrate to create a Seebeck coefficient variation in a single sheet of semiconductor. The Seebeck coefficient is changed locally by reducing its interaction with the substrate by suspending the 2D crystal over holes or by increasing the interaction with the substrate by locally applying pressure to it. Scanning thermal microscopy and scanning photocurrent microscopy methods identify the formation of a thermoelectric junction across the substrate-engineered regions [3]. This work presents substrate engineering as an innovative approach for making single-material thermocouples.

References

[1] Buscema, M., Barkelid, M., Zwiller, V., van der Zant, H. S., Steele, G. A., & Castellanos-Gomez, A., Nano letters, 13(2) (2013) 358-363.
[2] Harzheim, A., Spiece, J., Evangeli, C., McCann, E., Falko, V., Sheng, Y., Warner, J.H., Briggs, G.A.D., Mol, J.A., Gehring, P. and Kolosov, O.V., Nano letters., 18(12) (2018) 7719-7725.
[3] Harzheim, A., Evangeli, C., Kolosov, O. V., & Gehring, P., 2D Materials, 7(4) (2020), 041004.

Figures

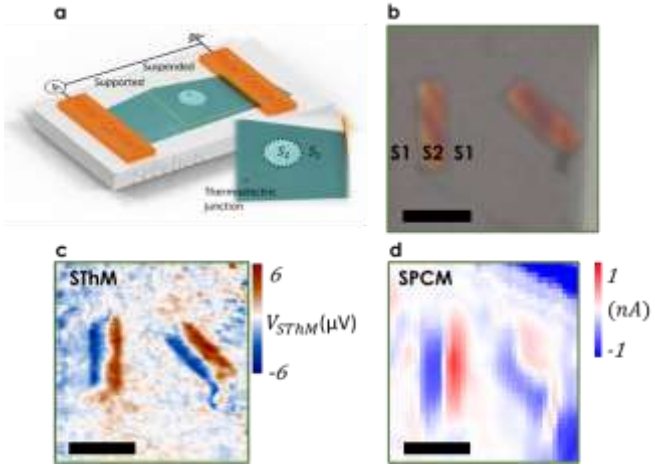


**Figure 1:** a) Schematic of a substrate-engineered device b) Optical microscope image of a multi-layered $MoS_2$. The crystal is suspended on two rectangular holes (orange areas). c) SThGM thermovoltage map d) photocurrent map. Scale bar: 3 µm.