# Electronic Transport Properties of Suspended Few-nm Wide Black Phosphorus Nanoribbons

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Theoretical studies of few-nm wide black phosphorus nanoribbons have revealed highly tunable, width-dependent properties such as bandgap magnitude and carrier mobility.[1,2] Due to the atmospheric stability issues of black phosphorus in the few-layer regime and a lack of suitable lithographic patterning techniques, these structures have yet to be reported. Here, we demonstrate the fabrication of few-nm wide and thick black phosphorus nanoribbons via in situ electron beam nanosculpting (Figures 1 and 2).[3] We also present in situ orientation- and width-dependent two-terminal electronic transport measurements of these structures. These measurements yield valuable insight into the semiconducting properties of black phosphorus and its associated lower-dimensional nanostructures.

## References

[1] H. Guo, N. Lu, J. Dai, X. Wu, X.C. Zeng, J. Phys. Chem. C, 118 (2014) 14051-14059.
[2] L.C. Xu, X.J. Song, Z. Yang, L. Cao, R.P. Liu, X.Y. Li, Appl. Surf. Sci., 324 (2015) 640-644.
[3] P. Masih Das, G. Danda, A. Cupo, W.M. Parkin, L. Liang, N. Kharche, X. Ling, S. Huang, M.S. Dresselhaus, V. Meunier, M. Drndic, ACS Nano, 10 (2016) 5687-5695.

## Figures

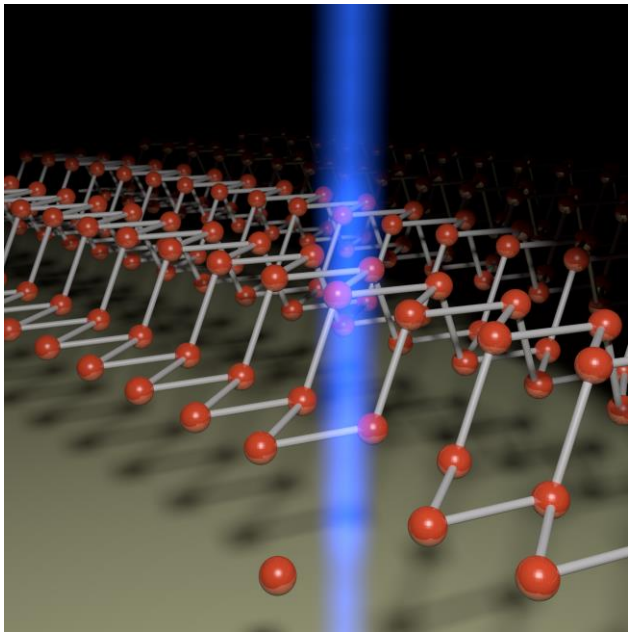

**Figure 1:** Illustration showing electron beam (blue) nanosculpting on the puckered honeycomb lattice (orange) of monolayer phosphorene.

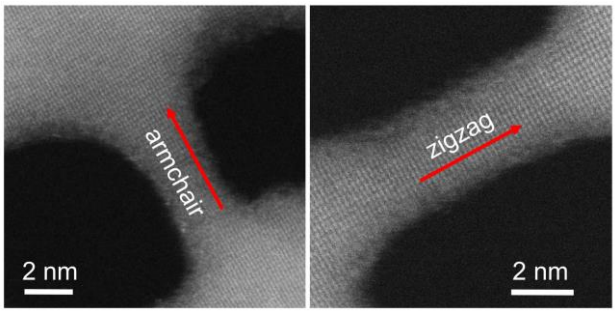


**Figure 2:** Aberration-corrected scanning transmission electron microscopy (AC-STEM) image of a 2.5-nm-wide armchair (left) and a 2.8-nm-wide zigzag (right) nanoribbon that have been nanosculpted in suspended black phosphorus.