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Nitrogen doped graphene with diamond like bonds achieves unprecedented energy density

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Supercapacitors have attracted great interest because of their fast, reversible operation and sustainability. However, their energy densities remain below those of batteries. In the last decade, supercapacitors with an energy content of ~110 Wh L^{-1} at a power of ~1 kW L^{-1} were developed by leveraging the open framework structure of graphene-related architectures. We report reaction of fluorographene with nitrogen source which enables the preparation of a material combining graphene-type sp^2 layers with tetrahedral C-C bonds and nitrogen superdoping (16%). This material, with diamond-like bonds and and an ultra-high mass density of 2.8 g cm^{-3}, is delivering unprecedented energy densities of 200 Wh L^{-1} (at power of 2.6 kW L^{-1}) and 143 Wh L^{-1} (at power of 52 kW L^{-1}). These findings open a route to materials whose properties may enable a transformative improvement in the performance of supercapacitor components.

References

[1] Z. Li, S. Gadipelli, H. Li, C. A. Howard, D. J. L. Brett, P. R. Shearing, Z. Guo, I. P. Parkin and F. Li, Nat. Energy, 2020, 5, 160–168.

[2] Y. Gogotsi and P. Simon, Science, 2011, 334, 917–918.

Figures

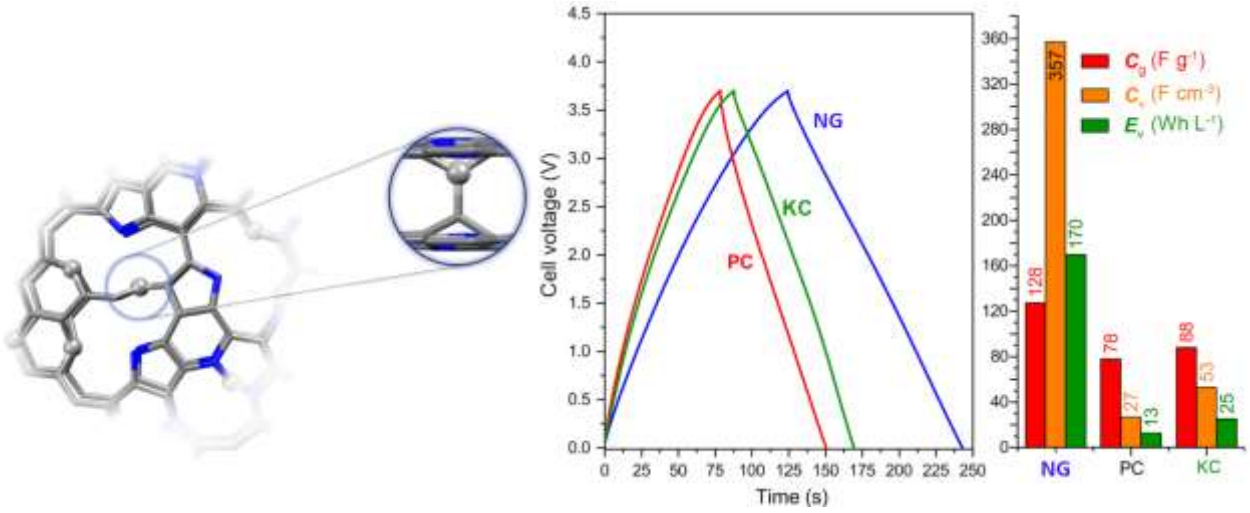

Figure 1: Left panel: Theoretical model of GN3 structural fragment (C:N atomic ratio of *ca.* 84:16) optimized by first-principles spin-polarized DFT calculations. **Right panel:** Comparison of the GN3 cell with symmetric cells made using commercial carbons with their performance at 2 A g^{-1}.