# Vertically-oriented graphene nanosheets (VOGNs) for micro-supercapacitor devices: Design, performance and comprehension

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VOGNs, as an innovative and robust 3D nanostructured material, has attracted a great deal of attention in the field of supercapacitors due to their unique morphological, structural and physical properties.[1] In this regard, we have originally reported the elaboration of ECR-CVD grown VOGN electrodes for micro-supercapacitor applications. The device exhibited an excellent electrochemical double layer behaviour operating at a large cell voltage of 4V employing an ionic liquid electrolyte ($PYR_{13}$ TFSI). Thereby, promising energy and power density values were achieved keeping an outstanding cycling stability.[2] More recently, we have carried out several approaches in order to improve the electrochemical performance of such devices by means of doping (e.g plasma nitrogen) and functionalization on VOGN surface using pseudo-capacitive organic materials. Particularly, nitrogen-doped VOGNs showed to be an effective strategy for that purpose. Thus, a high volumetric capacitance (13 F $cm^{-3}$), energy (28 mWh $cm^{-3}$) and power (360 W $cm^{-2}$) density in presence of $N_{1114}$ TFSI as electrolyte were evaluated. Furthermore, a capacitance retention of ~80% after $3 \cdot 10^5$ galvanostatic charge-discharge cycles was also verified. Regarding the state-of-the-art, these results reflect one of the highest electrochemical performances dealing with carbonaceous material supercapacitors in terms of power and energy density.
Finally, we are currently investigating the comprehension of energy storage mechanisms associated to VOGNs, which is still a big challenge to be unveiled. Accordingly, in this talk, an overview of our different strategies aforementioned will be presented.

## References

[1] Z. Bo, S. Mao, Z. J. Han, K. Cen, J. Chen, K. Ostrikov, Chem. Soc. Rev. 44 (2015) 2108
[2] D. Aradilla, M. Delaunay, S. Sadki, J.-M. Gérard, G. Bidan, J. Mater. Chem. A, 38(3) (2015) 19254

## Figure

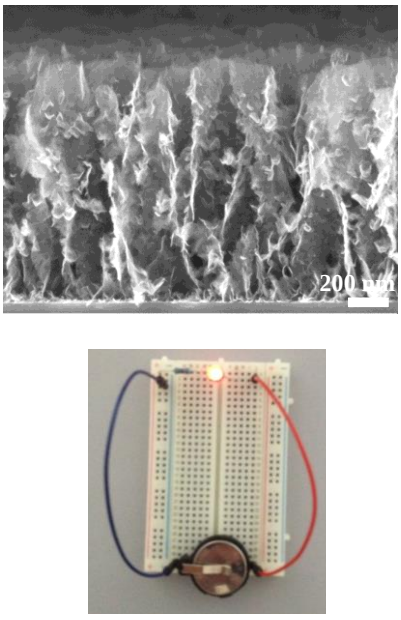


**Figure 1:** (Top) SEM micrograph corresponding to a cross-sectional view of ECR-CVD grown VOGNs on silicon substrate. (Down) Technological application of a VOGN-based supercapacitor