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► **To cite this version:**

Lionel Dubois, F. Duclairoir, Stéphanie Pouget, Hakima Mendil-jakani, Yassine Ben Cherifi. Advanced characterization of pillared graphene-based materials for supercapacitors. Carbon 2023, Jul 2023, Cancun, Mexico. hal-04823892

HAL Id: hal-04823892

<https://hal.science/hal-04823892v1>

Submitted on 6 Dec 2024

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Advanced Characterization of Pillared Graphene-Based Materials for Supercapacitors

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Materials for supercapacitors have to display **large surface area** to maximize the density of adsorbed ions [1], but they must also possess a **hierarchical porosity (Fig. 1)** to favour ions diffusion. Graphene-derived materials are studied as they –theoretically- combine all these porosity-related parameters. However experimentally the achieved capacitance remains limited because **graphene sheets tend to re-aggregate**. Our group has selected a method to avoid this issue by creating an **expanded graphene structure by bridging and separating the sheets using aliphatic diamine pillars**. These assemblies are called **Pillared Graphene Materials (PGM)**. Electrochemical results showed that these PGM **display higher capacitance than reference non pillared materials** [2,3]. However, it was not possible to correlate these storage performances improvements to adsorption active surface area determined with N₂ gas sorption (BET), which questions the suitability of this technique for measuring the full porosity of these samples. Therefore, to further correlate storage performances to structure properties, we started using **small angle X-ray/neutron scattering (SAXS/SANS) techniques which are perfectly suited to characterize the sample structure, and reveal mesoscale porosities (~20 to 140 nm)**.

In the frame of this presentation, we will show how **SAXS/SANS** have been applied to **pristine materials but also to specifically formulated samples (pellet, electrodes)** in order to highlight structural differences arising from **synthesis/formulation protocols or from molecular pillaring**. Reference samples morphologies were also shown to be very dependent of the synthesis method.

References

- [1] M. Salanne, et al, Nat. Energy 2016.
- [2] Banda, et al, J. Power Sources 2017.
- [3] Banda et al., ACS Nano, 13 (2019).

Figures

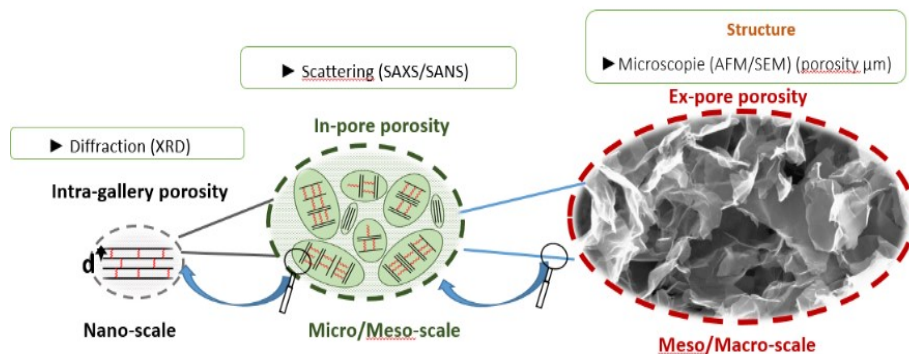


Fig. 1 Conceptual scheme of the different level of porosity in pillared graphene materials