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### **3D graphene based architectures for environmental applications**

R. M. Firdaus<sup>a,b</sup>, C. De Melo<sup>a</sup>, J.F. Pierson<sup>a</sup>, S. Migot<sup>a</sup>, M. Emo<sup>a</sup>, A. R. Mohamed<sup>b</sup>, B. Vigolo<sup>a,\*</sup>

<sup>a</sup>Université de Lorraine, CNRS, Institut Jean Lamour, F-54000 Nancy, France

<sup>b</sup>School of Chemical Engineering, Engineering Campus, Universiti Sains Malaysia, 14300 Nibong Tebal, Seberang Perai Selatan, P. Pinang, Malaysia

[\\*Brigitte.Vigolo@univ-lorraine.fr](mailto:Brigitte.Vigolo@univ-lorraine.fr)

Three-dimensional (3D) graphene-based macrostructures, GBMs, also referred to as aerogels, foams or sponges, have drawn immense interest these last ten years due the combination of interesting properties such as high surface area and porosity, chemical tunability and stability [1]. These GBMs offer high application potential including CO<sub>2</sub> adsorption, water treatment, batteries, sensors, catalysis, etc. However, due to lack of control of the self-assembling process, GBMs often suffer of restacking phenomenon during the assembly phenomenon which significantly lessens the outcome accessible surface. Exploiting the high surface of graphene within these GBMs is particularly important to develop efficient absorbents for water or air depollution. From literature, it is still not clear which of the physical (pore size, surface area) or the chemical (nature of the surface functional groups or other chemical modification) properties of GBMs impact their absorption capacity [2]. More recently, combination of graphene with inorganic compounds such as metal-based nanoparticles or thin films to develop hybrid porous nanomaterials is gaining of attention for environmental applications.

In this paper, we will provide a comprehensive study about the main issues to overcome development of GBMs and the investigation of their structural properties. Several 2D and 3D all-graphene based materials have been prepared and chemically modified for the purpose to be used for CO<sub>2</sub> capture. Our results show a significant enhancement of CO<sub>2</sub> absorption capacity after activation. The possible involved mechanism will be discussed [3]. Based on more recent results, preparation of alumina-graphene porous hybrids for depollution

application will be as well described. Alumina is here deposited by atomic layer deposition providing a well-suitable deposit method for such porous graphene support. Thanks to an in-depth characterization of the prepared 3D graphene-alumina hybrid material by means of high resolution transmission electron microscopy analysis carried out on a thin foil lamella prepared by focused ion beam, we report here a successful preparation of highly porous alumina by a well-controlled method rarely reported.

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- [3] R.M. Firdaus, A. Desforges, M. Emo, A.R. Mohamed, B. Vigolo, Physical and Chemical Activation of Graphene-Derived Porous Nanomaterials for Post-Combustion Carbon Dioxide Capture, *Nanomaterials.* 11 (2021) 2419. <https://doi.org/10.3390/nano11092419>.