Dye-sorption in liquid for surface area analysis

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Materials interact with their surrounding through their surfaces. Thus, several physical properties of solids, such as adsorption, degradation, thermal stability, etc. as well as its role in chemical reactions as a reagent or catalyst is also governed by the surface. Thus, the characterization of the surface is essential to predict the properties of the materials and their potential applications. The SA measurement is extremely important as it provides a measure of the exposure that a solid has towards the surrounding environment. One of the most used technique to measure SA is based on gas-sorption, where the gas penetrates into the pores, sit on the inner surface and measuring the amount of gas used up in covering the surface, the surface area of a particular solid can be measured with greater accuracy. Gas adsorption is usually described by isotherms (BET model),[1] i.e. the amount of adsorbate on the adsorbent as a function of its pressure at constant temperature. Although it is widely used to measure the SA of granulates, powders micro-fibers and metallic foams,[ISO 9277-2010] such technique is affected by several limitations, such as dimensions of solid objects of a few mm and minimum surface area (SA_{min}) of 4 m^2.[2] Moreover, the measurement procedures require vacuum-gas cycles and can cause mechanical stress in soft or fragile samples, closing the pores. Here, we present a protocol for SA measurement technique based on the adsorption of commercial dye (Methylene Blue) in green solvents (water, IPA) where isotherms are described in term of BET-modified model.[3] The protocol has been successfully tested on a wide range of materials: such as single layer graphene oxide nanosheet in water, graphite micro-powders, granular activated carbons, polymeric micro-fibers used as tap water filters, polymeric fabrics, metallic foams, ZnO ans Si nanobrushes.[4] In particular, the proposed protocol allows to measure the SA of atomic-flat surface as 1x1 cm^2 Si(111) substrate proving that the SA_{min} is about 4 orders of magnitude better than that achievable with gas-sorption BET.

References

[1] S. Brunauer et al., JACS 60 (1938) 309-319.
[2] https://www.micromeritics.com/Repository/Files/micro_tech_tip_14-surface-area-analyses.pdf
[3] A. Ebadi et al., Adsorption 15 (2009) 65-73.
[4] A. Kovtun et al., Nanoscale 11 (2019) 22780-22787; L. Maiolo et al., Biosensors and Bioelectronics: X 13 (2023) 100309

Figures

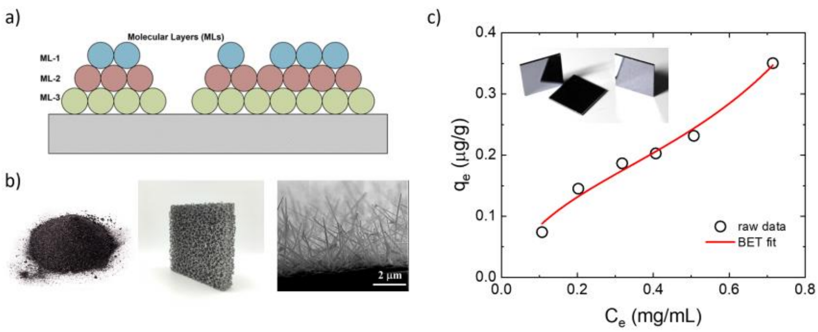

Figure 1: The process of BET multilayer adsorption, b) list of materials tested and c) isotherm measured on Si substrate