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Benchmarking of Graphene-based Materials: Real Commercial Products vs. Ideal Graphene

There are tens of industrial producers claiming to sell graphene and related materials (GRM), mostly as solid powders. Recently the quality of commercial GRM has been questioned, and procedures for GRM quality control were suggested using Raman Spectroscopy or Atomic Force Microscopy [1]. Such techniques require dissolving the sample in solvents, possibly introducing artefacts.

A more pragmatic approach is needed, based on fast measurements and not requiring any assumption on GRM solubility. To this aim, we report here an overview of the properties of commercial GRM produced by selected companies in Europe, USA and Asia. We benchmark: A) size, B) exfoliation grade and C) oxidation grade of each GRM vs. the ones of “ideal” graphene and, most importantly, vs. what reported by the producer. In contrast to previous works, we report explicitly the names of the GRM producers and we do not re-dissolve the GRM in solvents, but only use techniques compatible with industrial powder metrology [2]. In previous work we have established an analysis procedure for XPS data that allows an accurate estimation of O/C ratio and of the % C-C sp^2 bonds [3]. A general common trend is observed: products having low defectivity (% sp^2 bonds >95%) feature low surface area (<200 m^2/g), while highly exfoliated GRM show a lower sp^2 content [3], demonstrating that it is still challenging to exfoliate GRM at industrial level without adding defects.

References

- [1] Kauling A.P., Seefeldt A.T., et al., *Adv. Mater.* 30 (2018) 1803784
- [2] Kovtun A., Treossi E., et al., *2D Mater* (2019), in press <https://doi.org/10.1088/2053-1583/aafc6e>
- [3] Kovtun A., Jones D., et al., *Carbon* 143 (2019) 268-275

Figures

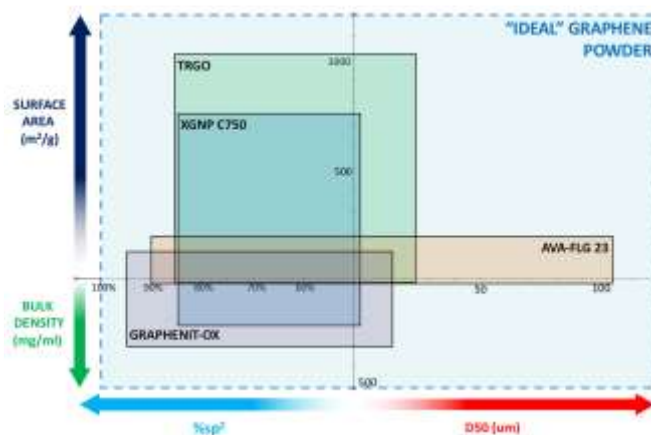


Figure 1: Composite graph using four axes to represent the different key properties of some of the GRM studied. The positive and negative branches of X and Y axis indicate Lateral size, % of sp^2 , specific surface area and density. Only selected GRM, with a high value in one or more of the selected properties, are shown for clarity. A large light-blue rectangle indicates the properties of an “ideal” graphene.