

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

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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. 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,
- 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

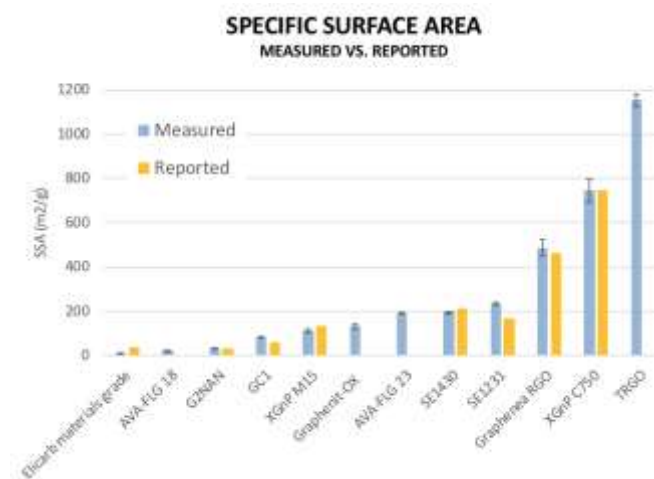
solvents, but only use techniques compatible with industrial powder metrology.

A general common trend is observed: products having low defectivity ( $\%sp^2$  bonds  $>95\%$ ) feature low surface area ( $<200$  m<sup>2</sup>/g), while highly exfoliated GRM show a lower  $sp^2$  content, demonstrating that it is still challenging to exfoliate GRM at industrial level without adding defects.

## References

- [1] Kovtun, A. et al., 2D Materials, 2, 025006 (2019)
- [2] Kovtun et al., A., Carbon, 268 (2019)
- [3] Liscio, A. et al., 2D Materials, 2, #025017 (2017)

## Figure



**Figure 1:** Comparison of measured surface area vs. values given by GRM producers.