

# Reproducible measurements of the lateral size and thickness of few-layer graphene flakes using SEM and AFM

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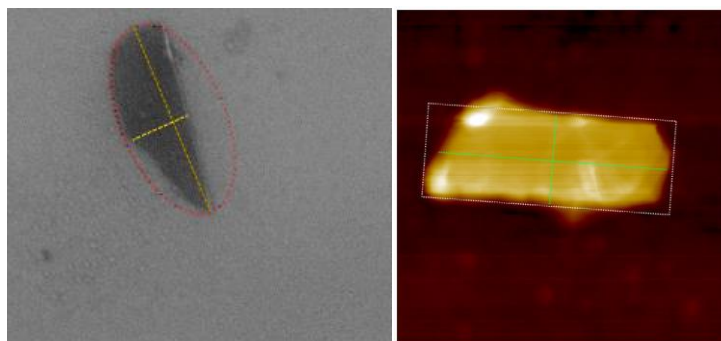
Graphene nanoplatelets (GNPs), typically produced as powders or in liquid dispersions are already starting to find commercial application via small-to-medium enterprises (SMEs) to multi-national corporations, for a large range of application areas. There are currently over 100 commercial 'graphene' producers worldwide, including leading producers in Europe, with an 'on paper' offering of materials with vastly different properties and types. However, the activity of many suppliers (and buyers) is hindered due to materials properties being unknown or poorly characterised, often consisting of graphite rather than GNPs or having large batch-to-batch variations. Real world products and applications suffer as a result. Thus, validated and disseminated measurement methods of GNPs are a key industry requirement. To this end, an international interlaboratory comparison (ILC) to determine the lateral flake size distribution of graphene nanoplatelets (GNPs) using scanning electron microscopy (SEM), and to then correlate this distribution to measurements of lateral flake size and thickness using atomic force microscopy (AFM), has been undertaken [1]. The outcomes of this ILC will directly input in the future revision of the international standard for measuring the structure of GNPs - ISO/TS 21356-1 [2,3], providing an insight on method variability and objective data to build robust and widely applicable measurement procedures across different instrument models and laboratories.

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## References

- [1] Despotelis, K; Pollard, A; Clifford, C; Paton, K (2022) VAMAS TWA 41 - Graphene and related 2D materials project 12 - Distribution of lateral size and thickness of few-layer graphene flakes using SEM and AFM. SEM and AFM measurement protocol. NPL Report. AS 103. <https://doi.org/10.47120/npl.AS103>
  - [2] [ISO/TS 21356-1](#) Nanotechnologies — Structural characterization of graphene — Part 1: Graphene from powders and dispersions
  - [3] Clifford, C.A., Martins Ferreira, E.H., Fujimoto, T. et al. The importance of international standards for the graphene community. *Nat Rev Phys* 3, 233–235 (2021). <https://doi.org/10.1038/s42254-021-00278-6>
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## Figures



**Figure 1:** An example of high-resolution images, SEM (left) and topographic AFM (right) of individual particles showing the measurement methodology [1].