

# ASTM Standard Guide for Characterization of Graphene Flakes

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As graphene based materials move from the laboratory to production, there is an increasing interest in a wide range of applications such as membrane filtration, batteries, printed electronics, and graphene-polymer composites. Significant advances in nanometrology, the science of measurement at the nanoscale, are essential for the continued development of nanotechnology-based consumer products. Challenges include new and improved measurement approaches with higher spatial resolution, accuracy and sensitivity, preparation of standards and reference materials with nanoscale features and the ability to correlate properties and function for graphene based nanomaterials. A Standard Guide has been developed at the ASTM-E56 Nanotechnology Committee, which provides guidance on the measurement approaches for assessment of lateral flake size, average flake thickness, Raman intensity ratio of the D to G bands, and carbon/oxygen ratio for graphene and related products. This Standard Guide is intended to serve as an example for manufacturers, producers, analysts, and others with an interest in graphene and related products such as graphene oxide (GO) and reduced graphene oxide. At the same time, many questions have been raised relating to the potential impact of nanomaterials on human health and the environment. Investigations on commercial available and in-house prepared GO samples were also carried out on six cell lines, and the effectiveness of four viability assays was assessed. The impact of different processing approaches (such as base washing, sonication and cleaning) on the flake morphology, composition and cytotoxicity of the GO materials was systematically evaluated. The overall toxicity of GO greatly varied between cell lines; multiple cell lines were also tested to estimate their response to varying GO flake sizes and processing induced morphology changes.

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## References

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- [2] Gies, V.; Zou, S. *Toxicol. Res.*, 2018, *7*, 93-101.
- [3] Coleman, B.; Knight, T.; Gies, V.; Jakubek, Z.; Zou, S. *ACS Appl. Mater. Interfaces* 2017, *9*, 28911-28921.
- [4] Vobornik, D.; Zou, S.; Lopinski, G. *Langmuir* 2016, *32*, 8735-8742.

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## Figures

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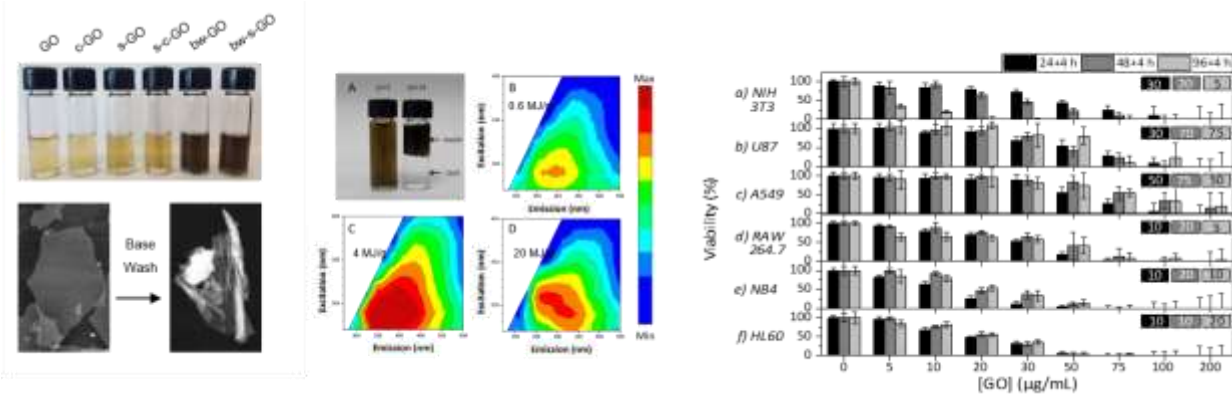


Figure 1. Manipulation and quantification of graphene oxide flake size: photoluminescence and cytotoxicity