

Impact of graphene oxide particle morphology on the extent of exfoliation of reduced graphene oxide during the rapid thermal expansion process

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Abstract

The rapid thermal expansion of graphene oxide (GO) remains one of the most scalable ways to produce reduced graphene oxide (rGO) powder with high surface area and with a relatively high fraction of single-layer. While this method and its variants have been scaled up commercially, the detailed transition of GO to rGO during the process is not fully understood. Most of the previous studies on the thermal exfoliation of GO are limited to investigating the effect of graphite nature, oxidation methods, and heat transfer on final rGO, while the effect of GO morphology and chemistry has been overlooked. Since the rapid expansion process is thought to involve an autoexothermic reaction and a reaction time that exceeds the diffusion time of gaseous decomposition products, we hypothesize that morphological properties such as density, surface area and crystallinity of the GO powders used have a significant impact on the surface area of the resulting rGO and its yield of single layers. In this work, we systematically engineered GO particle morphology by tuning spray drying parameters, and we prepared a range of GO powders with distinct morphologies. These powders were aerosolized and passed through a laboratory tube furnace under continuous flow conditions for exfoliation. Our results show that these morphological variations strongly influence the properties of the resulting rGO, including its specific surface area (SSA) and particle morphology. Notably, the impact of precursor morphology is most pronounced at lower exfoliation temperatures, while at higher temperatures this dependence is reduced, suggesting a shift in the dominant exfoliation mechanisms.

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