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# Oxalic acid assisted expansion-reduction exfoliation of graphene oxide into graphene nanosheets

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**Abstract:** A novel approach to prepare graphene nanosheets was developed by exfoliating graphene oxide (GO) assisted with oxalic acid ( $\text{H}_2\text{C}_2\text{O}_4$ ). The expansion and reduction of GO were synchronously fulfilled through the decomposition of  $\text{H}_2\text{C}_2\text{O}_4$  impregnated into the interlayer of GO. The structure of the as-exfoliated graphene nanosheets were determined by a series of characterizations. The results showed that the as-exfoliated graphene nanosheets possessed ca. 10-layered thickness and the lower oxygen content. The mechanism was proposed that  $\text{H}_2\text{C}_2\text{O}_4$  played a role of the expansion-reduction associated effect in exfoliation.

**Keywords:** Carbon materials; Thin films; GO; Expansion; Exfoliation; Graphene

## 1. Introduction

As a single layer of carbon atoms tightly packed into a two-dimensional (2D) honeycomb  $\text{sp}^2$  carbon lattice, graphene nanosheets exhibited many dramatic properties, such as high thermal conductivity, superior mechanical and excellent electronic transportation properties. In past decade, there were some reports concerning the reduction of GO into graphene nanosheets by using various reductants such as hydrazine, oxalic acid and so on [1]. However, the reduction of GO was conducted in chemical exfoliation based on Hummers method. Among these reduction methods, the hydrazine-reducing method was a common way to prepare graphene nanosheets from graphite oxide, which was apt to cause the damage of size and structure of the as-prepared graphene nanosheets [2]. Most importantly, the high toxicity of hydrazine

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