

Rate and Mechanistic Investigation of Eu(OTf)₂-Mediated Reduction of Graphene Oxide at Room Temperature

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Abstract: Graphene, a two dimensional network of single atom thickness of carbon atoms has generated enormous attention in the recent past.¹⁻³ While reports are available focusing on the chemical synthesis of graphene, limited studies are documented in literature about the mechanistic investigation involved in such synthetic processes.⁴ Quite surprisingly, only a few reports are known in the literature about the kinetic studies of the reduction of graphene oxide (GO) to reduced graphene oxide (rGO).⁵ Herein we describe a fast, efficient and mild approach to prepare chemically reduced graphene oxide (rGO) at room temperature using divalent europium triflate {Eu(OTf)₂}.⁶ The characterization of solution-processable reduced graphene oxide has been carried out by various spectroscopic (FT-IR, UV-visible absorption and Raman), microscopic (TEM and AFM) and powder X-ray diffraction (XRD) techniques. Kinetic study indicates that the bimolecular rate constants for the reduction of graphene oxide are $13.7 \pm 0.7 \text{ M}^{-1}\text{s}^{-1}$ and $5.3 \pm 0.1 \text{ M}^{-1}\text{s}^{-1}$ in tetrahydrofuran-water and acetonitrile-water mixtures, respectively. The reduction rate constants are *two orders* of magnitude higher compared to the values obtained in the case of commonly used reducing agents such as hydrazine derivative, sodium borohydride and glucose-ammonia mixture. The present work introduces a feasible reduction process for preparing reduced graphene oxide at ambient conditions, which is important for bulk production of GO. More importantly, the study explores the possibilities of utilizing the unique chemistry of divalent lanthanide complexes for chemical modifications of graphene oxide.

References

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Figures

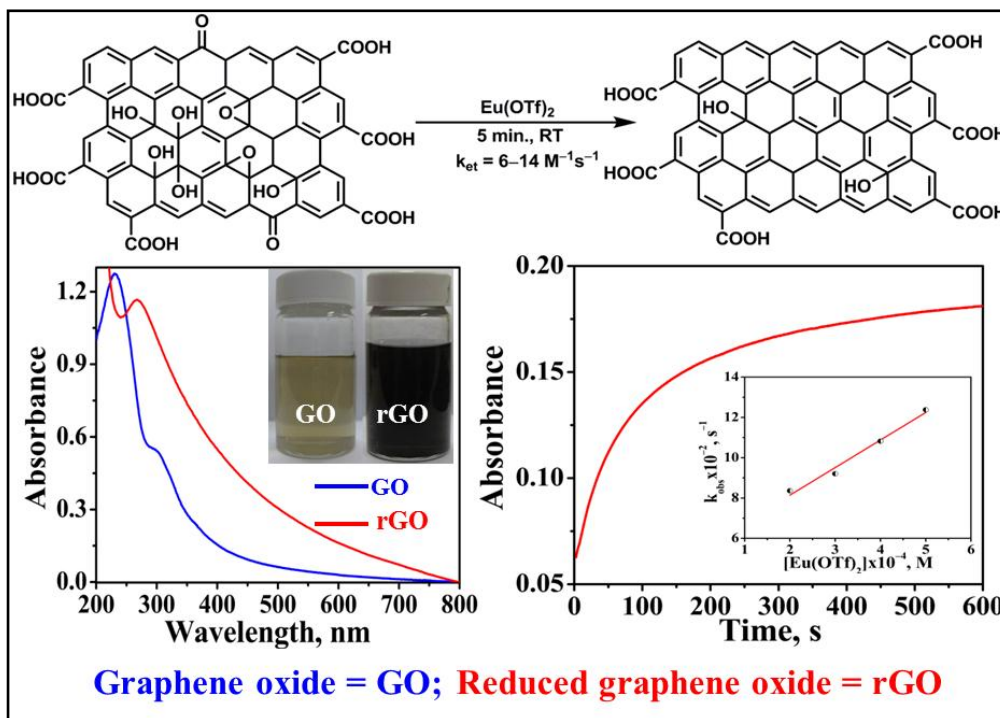


Figure 1. Schematic representation of reduction of GO by $\text{Eu}(\text{OTf})_2$ (top). Characterization of rGO by UV-visible absorption spectroscopy (bottom left). Kinetics growth trace of formation of the rGO and determination of bimolecular rate constant of reduction (bottom right).