Revealing the ultrafast process behind the photoreduction of graphene oxide[1]

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In order to harness the full potential of graphene there is a growing need to develop efficient production techniques, with particular emphasis on simplicity, robustness, and yield. A promising “green” method that has been championed in recent years is the irradiation of aqueous dispersions of graphene oxide with ultraviolet light. This process has been observed to occur in a vast variety of experimental conditions, and the exact chemical mechanism of the reduction from graphene oxide to graphene has remained elusive until now.

To this end, we have performed a series of ultrafast spectroscopy experiments which have shed light on the chemistry of this process: rather than direct reduction, an ultrafast photoinduced chain reaction was observed to be responsible for the graphene oxide reduction. The reaction is initiated by a femtosecond ultraviolet pulse that photoionizes the solvent, liberating solvated electrons, which trigger the reduction. The present study reaches the fundamental time scale of ultraviolet photoreduction of graphene oxide in solution, which is revealed to be in the picosecond regime. Characterization of the final product confirms the removal of oxygen containing groups and the restoration of the honeycomb carbon network of graphene.

The intimate understanding of this reaction gleaned from these experiments is an important step towards exploiting photoreduction of graphene oxide as a viable method to produce graphene. It also highlights the dramatic effect of the environment on the chemistry of graphene.

References

Figures

Illustration of the photoreduction mechanism of graphene oxide to graphene in solution.