

Low-temperature Exfoliation of Multilayer-Graphene Material from FeCl_3 and CH_3NO_2 Co-intercalated Graphite Compound

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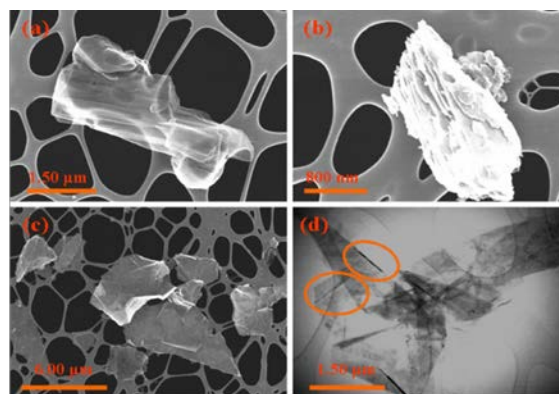
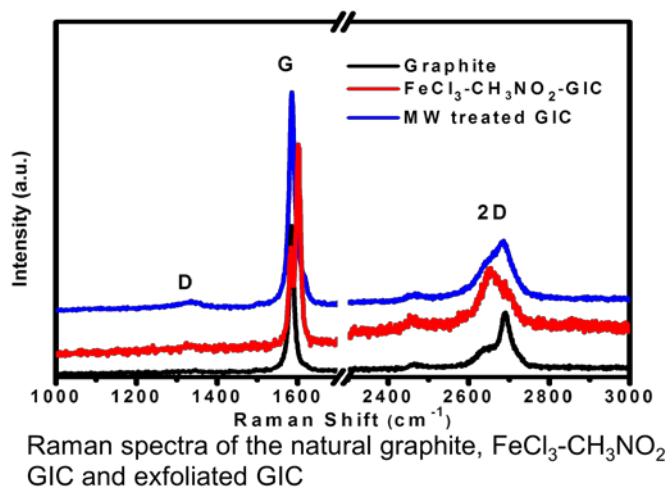
Achievement

We have developed a novel scalable method for the synthesis of high quality graphene materials via low-temperature exfoliation of graphite under mild chemical conditions. The method preserves energy and chemicals used in the generation of graphene materials via what have been energy consuming and chemically wasteful processes. We found that FeCl_3 and nitromethane (CH_3NO_2) co-intercalated graphite can be readily exfoliated to graphene sheet at the boiling temperature of water by heating in a microwave oven. The essence of this method is the rapid decomposition of nitromethane to gaseous products expanding within the galleries of graphene sheets. The mechanical force from the gas expansion overcomes the already weakened van der Waals forces and thus leads to the formation of graphene sheets.

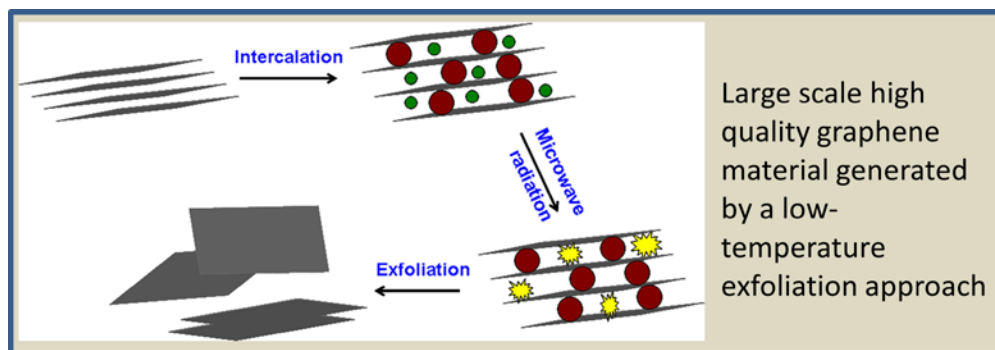
Significance

The large demand for high quality graphene materials makes the synthesis of graphene one of the key steps to meet various research needs. The chemical or physical exfoliation of graphite is a straightforward method to produce graphene with minimal synthesis effort, since it takes advantage of the existing graphene structure in crystalline graphitic materials.

We have demonstrated the exfoliation of graphite intercalation compounds by a method that circumvents the dramatic structural changes of graphene brought about by irreversible chemical functionalization. The method holds the promise for massive production of graphene with a low concentration of defects via a low-temperature, mild exfoliation approach.



(a & b) SEM images of $\text{FeCl}_3\text{-CH}_3\text{NO}_2$ GIC and conventionally heated GIC; (c) SEM image of microwave exfoliated graphene; (d) TEM image of microwave exfoliated graphene.



Fu, W. J.; Kiggans, J.; Overbury, S. H.; Schwartz, V.; Liang, C. D., *Low-temperature exfoliation of multilayer-graphene material from FeCl_3 and CH_3NO_2 co-intercalated graphite compound*, *Chemical Communications* **2011**, 47(18), 5265-5267.

This research was supported by the Center for Nanophase Materials Sciences, which is sponsored at Oak Ridge National Laboratory by the Office of Basic Energy Sciences, U. S. Department of Energy.