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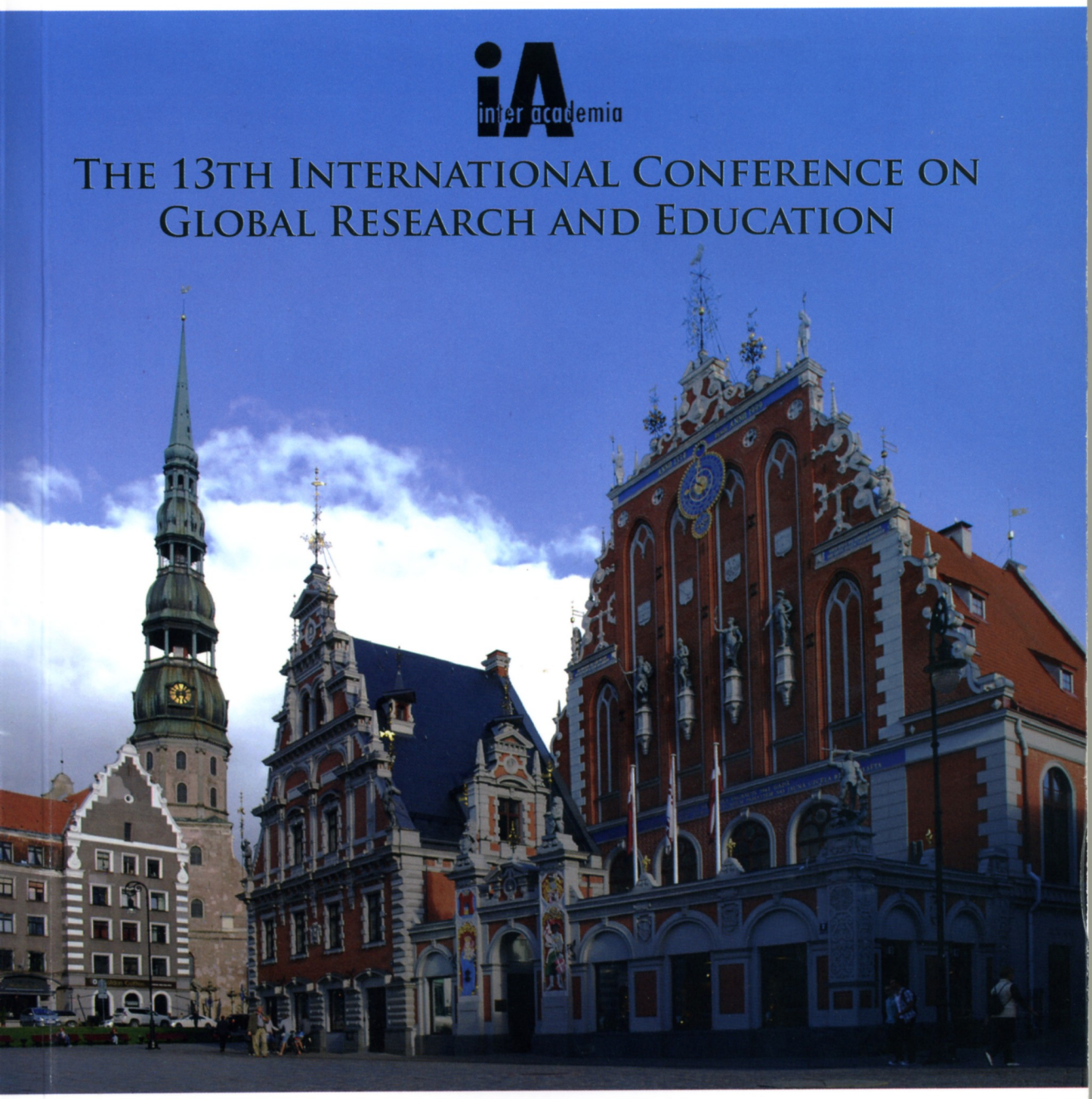

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DIGEST

Effect of Chemical Reduction on Pre-Exfoliated Graphene Oxide Structure and Electric Properties

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Summary

Graphene oxide (GO) reduction is a promising way for large scale synthesis of graphene. Pre-exfoliated graphite was oxidized and reduced. The material was compared to commercial graphene oxide and its reduced sample. The reduction process of graphene oxide was accomplished using sodium borohydride ($NaBH_4$) with variable-valence metal ion – cobalt – assistance. The reduced graphene oxide (RGO) was characterized by Raman spectroscopy. The particle size and suspension stability was determined. Electrical conductivity measurements of GO and RGO samples were done in the temperature range from -150°C to 85°C. Pre-exfoliation effect was determined.

Introduction

There are various reasons why graphene oxide has been a hot topic for the past years. One of the main reasons is the possibility to get graphene-like materials via chemical reduction. Chemical reduction of exfoliated graphene oxide is believed to be the most promising for large scale production of graphene-like materials [1].

Graphene oxide is an insulator, because the sp^2 conjugation is disturbed by the oxygen functional groups. The electrical conductivity can be regained by removing the oxygen groups, so restoring the π-bonds. That is mainly accomplished by reduction.

Chemical reduction can be done with various reagents and reaction conditions. Hydrazine monohydrate ($H_4N_2 \cdot H_2O$) [2] and sodium borohydride are the most commonly researched reducing agents [1].

Hydrazine disadvantages – toxicity and heteroatom impurities – lead to the usage of $NaBH_4$ for this study.

Materials and methods

To compare the effect of pre-exfoliation, thermally exfoliated graphite (TEG) was oxidised and reduced and compared with commercial GO and its reduced sample. Electrical resistance, zeta potential, particle size and structure characterized by Raman spectroscopy were investigated.

Results and discussion

Fig.1 shows that the reduced TEG oxide sample (RTEGO) has lower resistance in comparison with the reduced commercial GO sample (RGO).

Thermal pre-exfoliation of graphite significantly (more than 4 times) improves electrical conductivity of the reduced material.

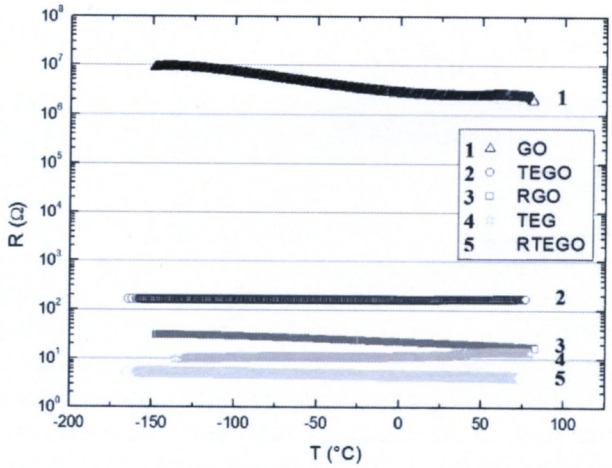

Fig. 1. Electrical resistance dependency on the temperature of commercial GO and reduced GO and TEG, TEG oxide and reduced TEG oxide.

By oxidizing the TEG, the thickness of graphene platelets decreases, thus we conclude that oxidation is a good way for additional exfoliation of graphite layers.
Raman spectroscopy shows that oxidized sample spectra are similar and reduced sample spectra are similar.

Conclusion

Pre-exfoliation of graphene oxide leads to better conducting and thinner graphene platelets.

References

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[2] S. Park, J. An, J. R. Potts, A. Velamakanni, S. Murali, and R. S. Ruoff, "Hydrazine-reduction of graphite- and graphene oxide", Carbon N. Y., vol. 49, no. 9, pp. 3019–3023, Aug. 2011.