Graphene Enhanced Electrode Performance for Li-ion Batteries

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Abstract

Li-ion batteries are the largest and fastest growing segment amongst the various battery technologies. They provide the highest energy density per unit weight and volume and is the only technology which offers a realistic solution for development of electric and hybrid vehicles. However there are still some major limitations which are preventing the mass scale production and adoption of electric vehicles. The battery pack in a car presently costs about 30% of the total car which makes the cars expensive. The maximum driving range of a car needs to go up significantly for it to be seriously considered for most customers. Last but not the least the safety issues of putting a huge high energy battery also needs to be sufficiently tackled. Hence the requirement for developing safer, lighter and cheaper batteries is driving enormous development in the field of Li-ion batteries.

Graphene Batteries focuses on improving existing and future candidate cathode and anode materials with the unique properties of graphene [1]. Graphene has exceptional electronic and thermal conductivity which will impart fundamental changes to the performance of the battery. GB has already made a prototype material in lab-scale which show 20 times higher conductivity than a "state-of-the-art" industrial material, with the same carbon-content, by using in-house prepared GO (Figure 2) subsequently thermally reduced to the graphene derivative RGO. By introducing graphene combined with special formulation techniques [2], we have calculated that our material can reduce the total cost of the battery by 30 – 40 %. An important part of the savings are related to reduction in the amount of additional materials needed, such as separators and conductive diluents in a Li-ion cell. It will significantly enhance the power of a battery and bridge the gap between high energy and high power cells currently offered in the market. Finally the materials will offer exceptional thermal properties which will increase the safety and life time of the battery translating into increased longevity and reduced depreciation costs of the battery.

The capacity in a battery cell depends on the amount of electrode material. A method to achieve a high capacity is to use a thick layer of electrode material. However this requires that the electrical conductivity of the electrode material is high.

LFP/Graphene composites as shown in the Figure 1 below provide both higher gravimetric and volumetric energy density than normal LFP-electrodes with same formulation. Extensive work is under way to reduce the graphene content in the electrodes such that the columbic efficiency and ultimately the cycle life of the cell is highly improved.

Applications targeted are batteries for EV, ships and smart grid.

References

[1] Wendelbo, R. and Fotedar, S. Norw. Patent application No. 20120917.
[2] Wendelbo, R. and Fotedar, S. Norw. Patent application No. 20121111.

Figures

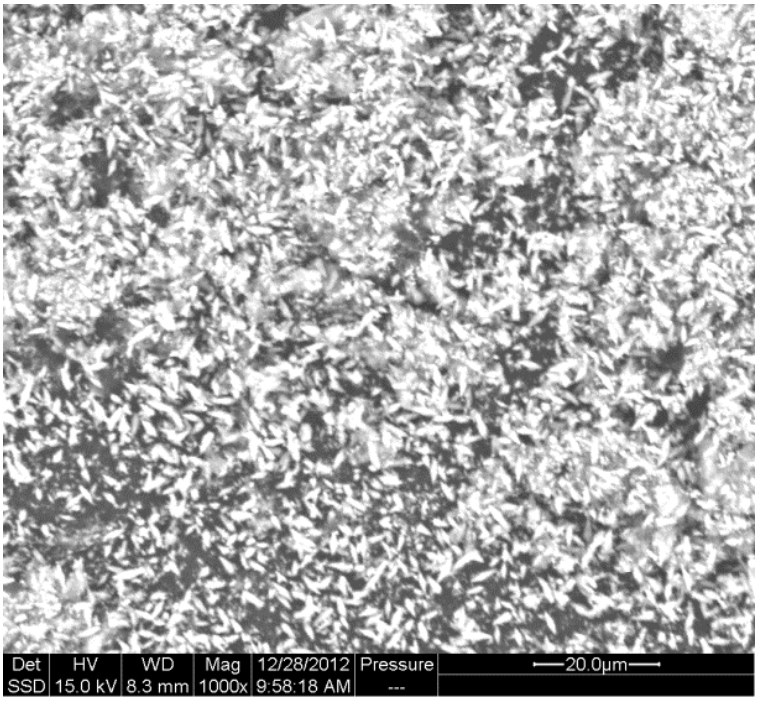

Figure 1. LFP with 2 % delaminated RGO

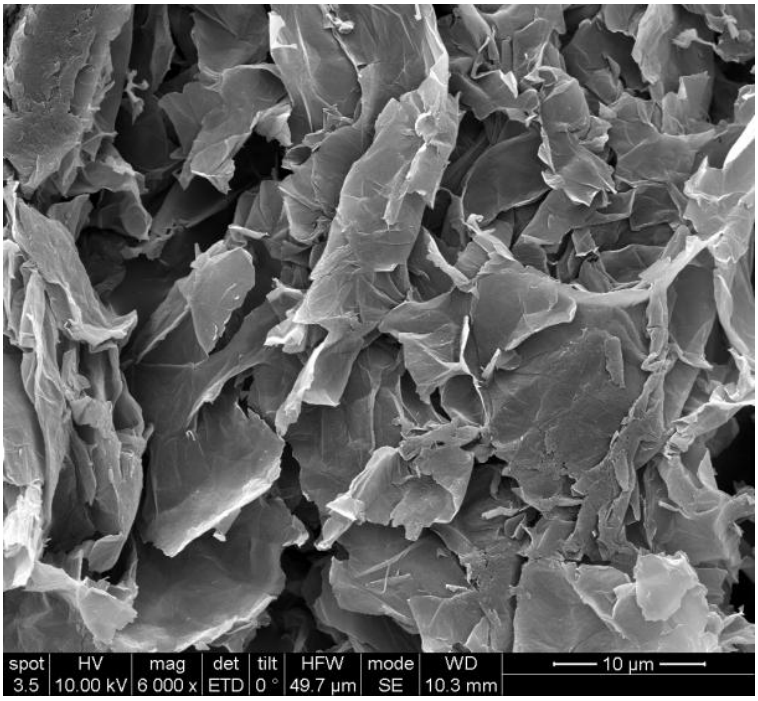

Figure 2. Original graphene oxide