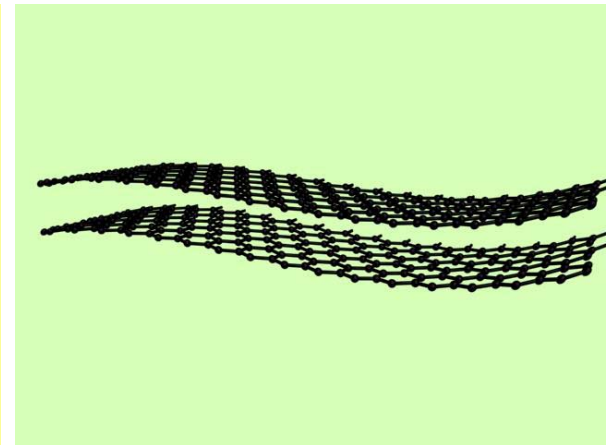
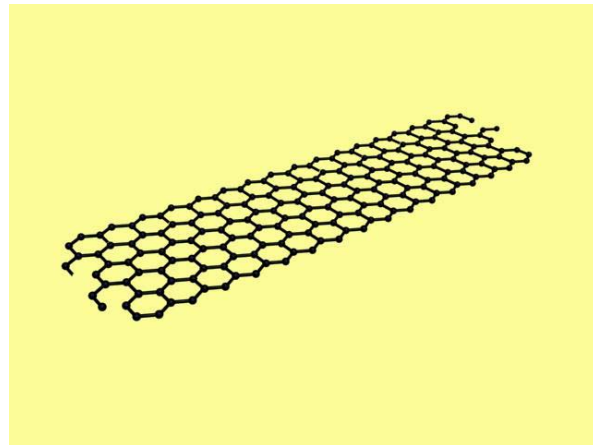


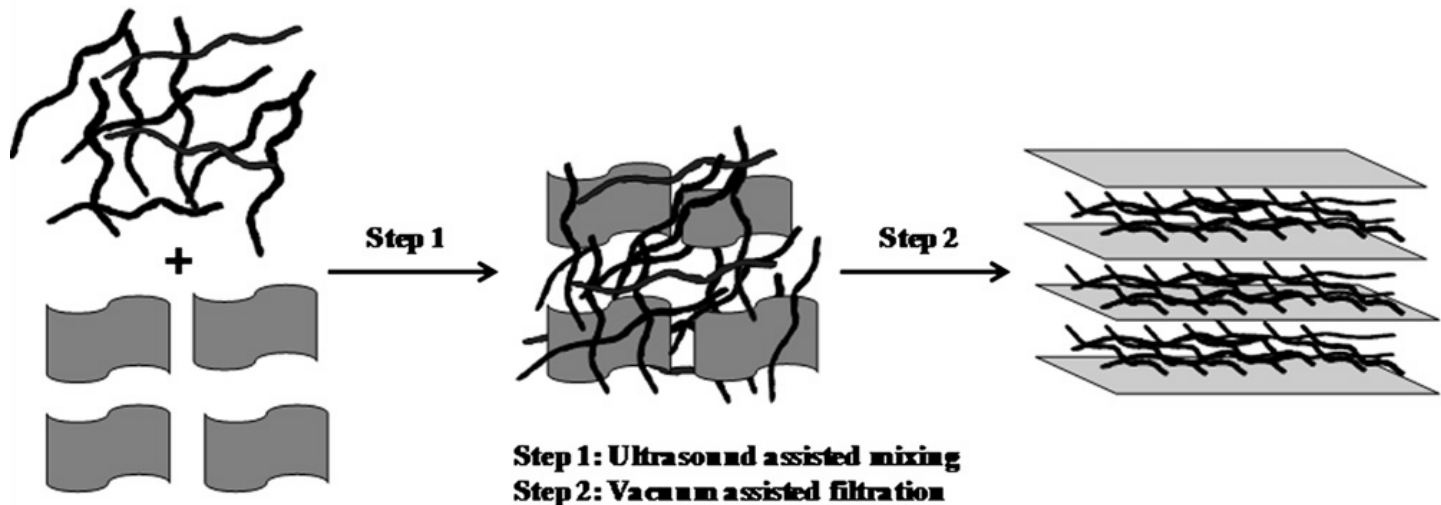
# Free-standing Paper-based Graphene Composites as Anode for Lithium Ion Batteries

Biqiong WANG  
Apr. 15<sup>th</sup> 2013



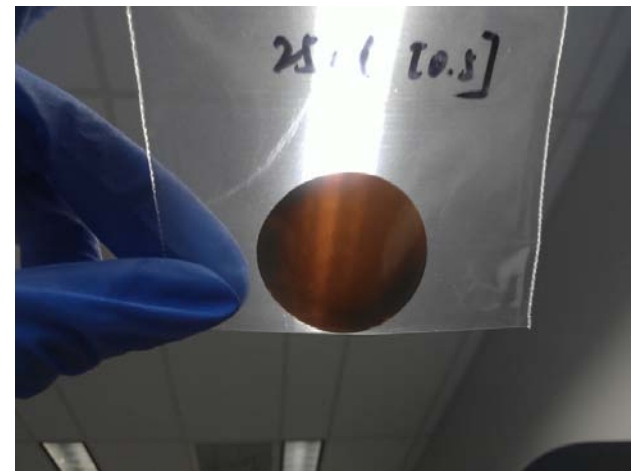
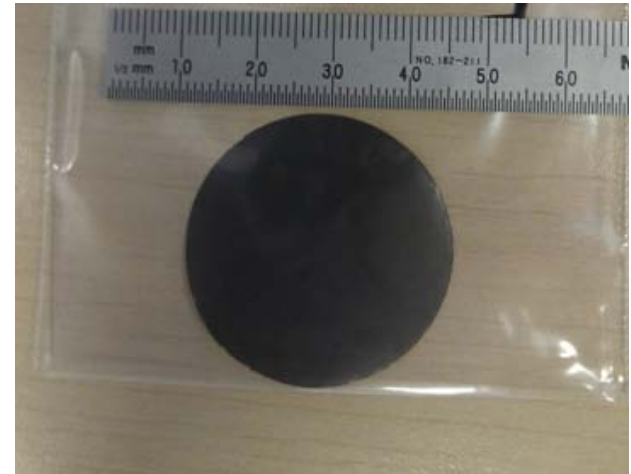
# Introduction

- Objectives:
  - To fabricate free-standing binder-free paper-based anode for Lithium ion batteries (LIBs);
  - To improve the battery performance by:
    - Using graphene as matrix, combined with other materials to fabricate composites;
    - $Li_4Ti_5O_{12}$  (LTO), CNTs, Si;



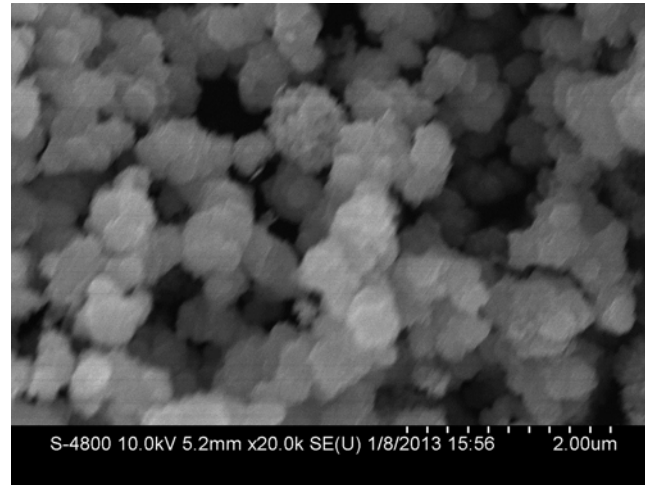
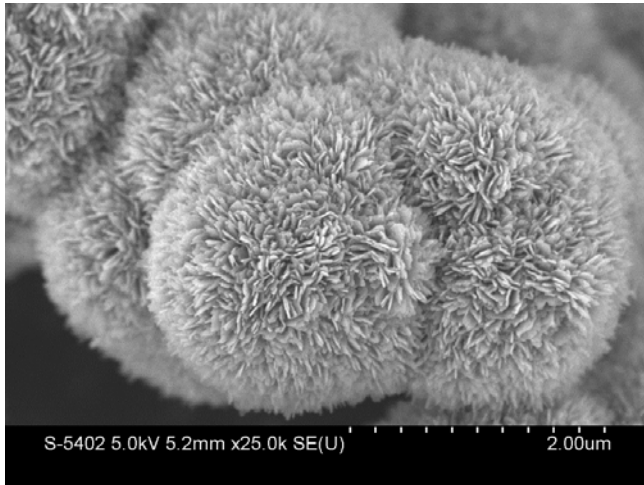
# Introduction

- **LTO**
  - Theoretical Capacity:  $\sim 175\text{mAh/g}$ ;
  - 'Zero Strain' – Structure stability;
  - Excellent cycling performance;
  - Poor conductivity;
- **Graphene**
  - Good mechanical properties;
  - Highly conductive;

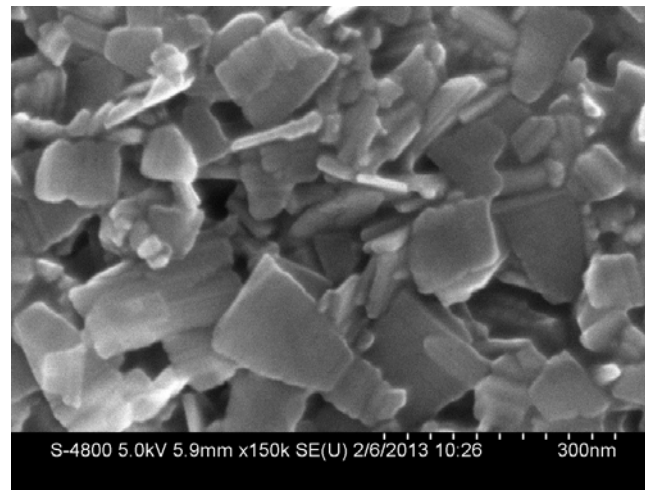
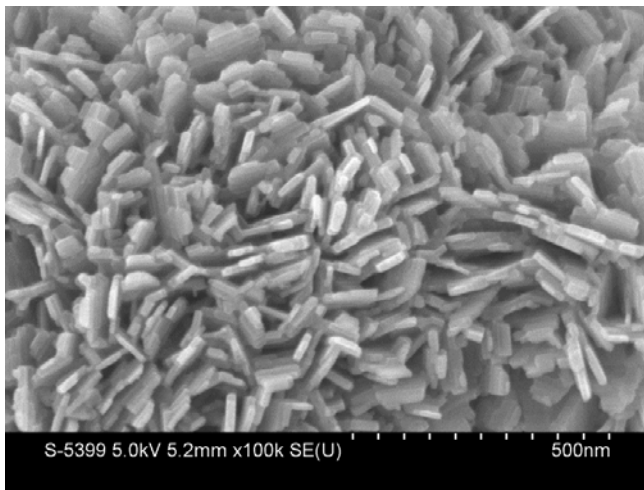


# Methology

- **LTO: Hydrothermal Method (130°C)**

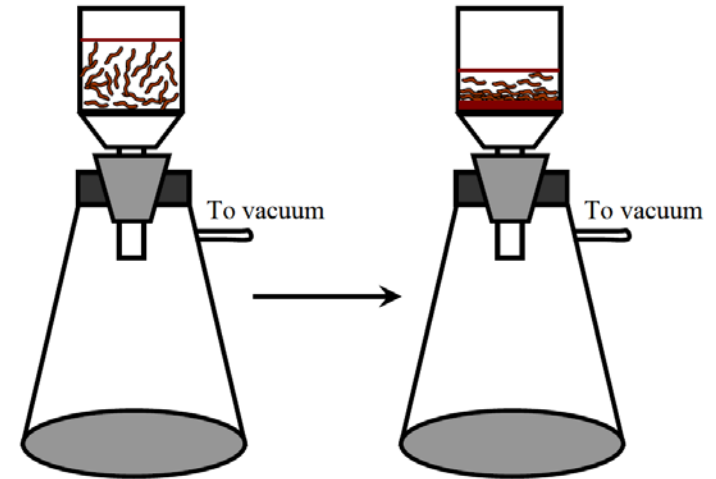


**Nanoparticles  
(150 °C)**



# Methodology

- Composites Paper Sheet:  
Vacuum Assisted Filtration



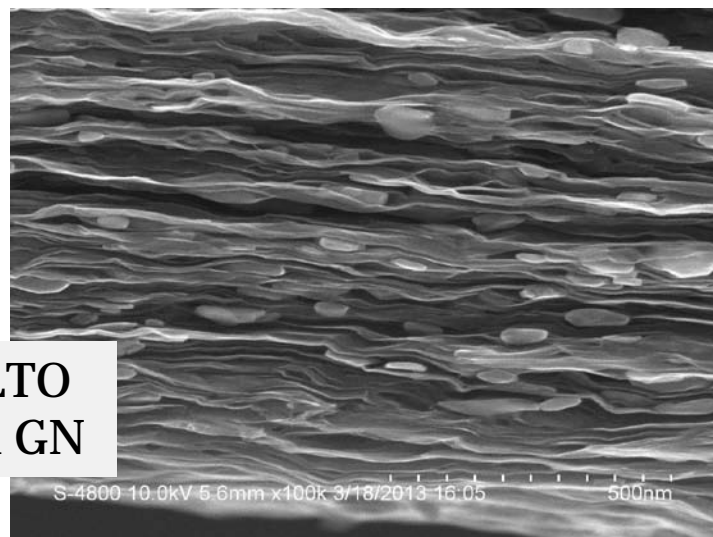
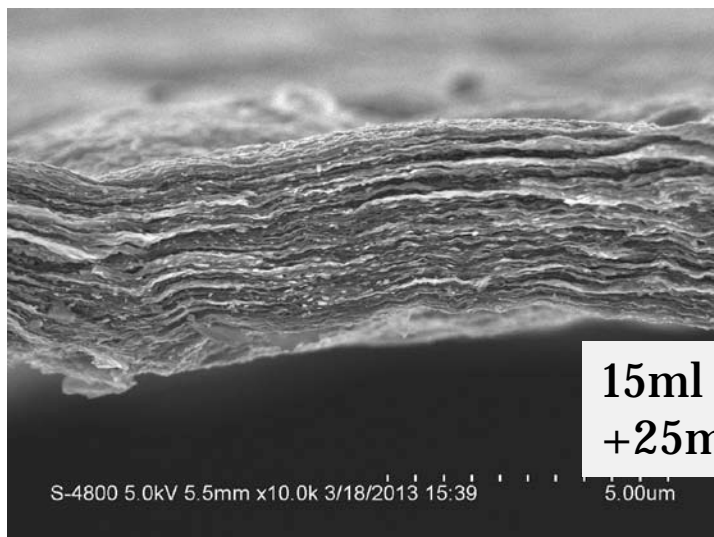
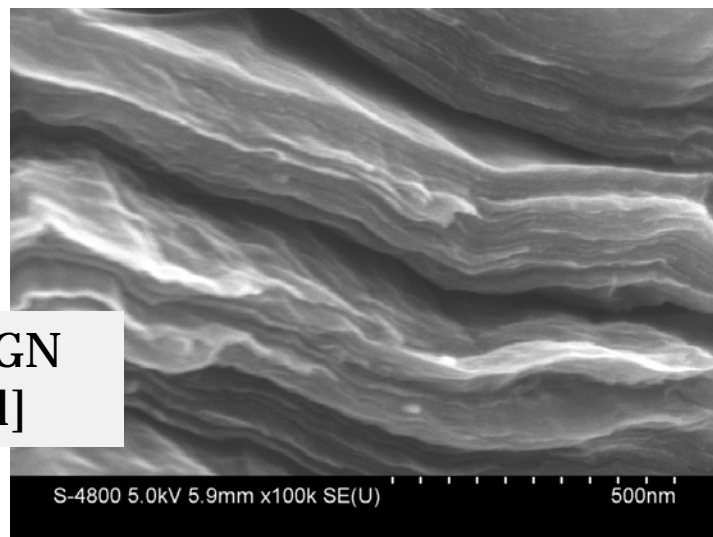
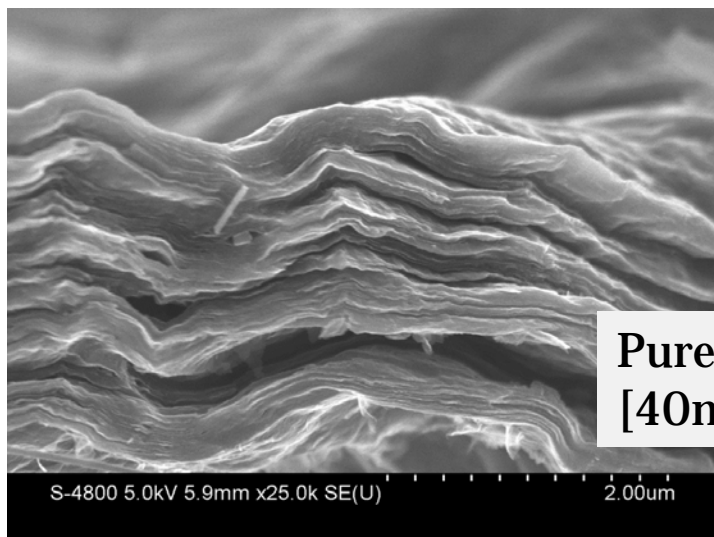
- LTO  $m_1$  + DI water **V1** → Sonication for **4hr** → Centrifugation for 5min at high speed → Upper solution;
- **V2** (0.5mg/ml) Graphite oxide dispersion solution + LTO dispersion solution → Sonication for **1hr**;
- Filtration;
- Heat treatment at **900°C** (1.5hr +2hr);

# Results

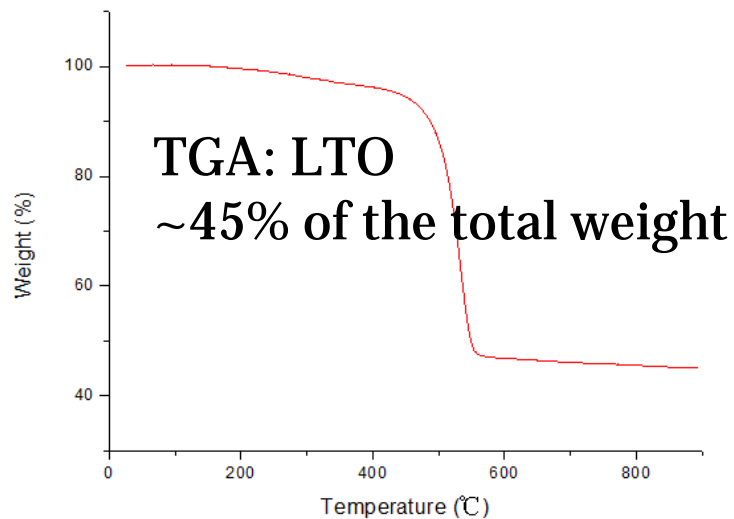
<b><math>m_1</math> (mg)</b>	<b>V1 (ml)</b>	<b>V2 (ml)</b>	<b>[con.] (mg/ml)</b>	<b>Volume Ratio</b>
15	15	25	0.5	3:5
30	15	25	0.5	3:5
45	15	25	0.5	3:5
10	10	20	0.5	1:2
20	10	20	0.5	1:2
30	10	20	0.5	1:2
Pure GN				

# Results

- SEM

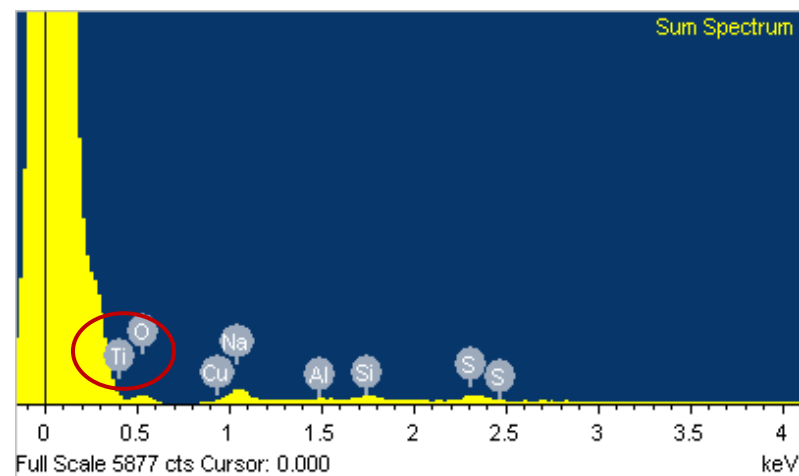
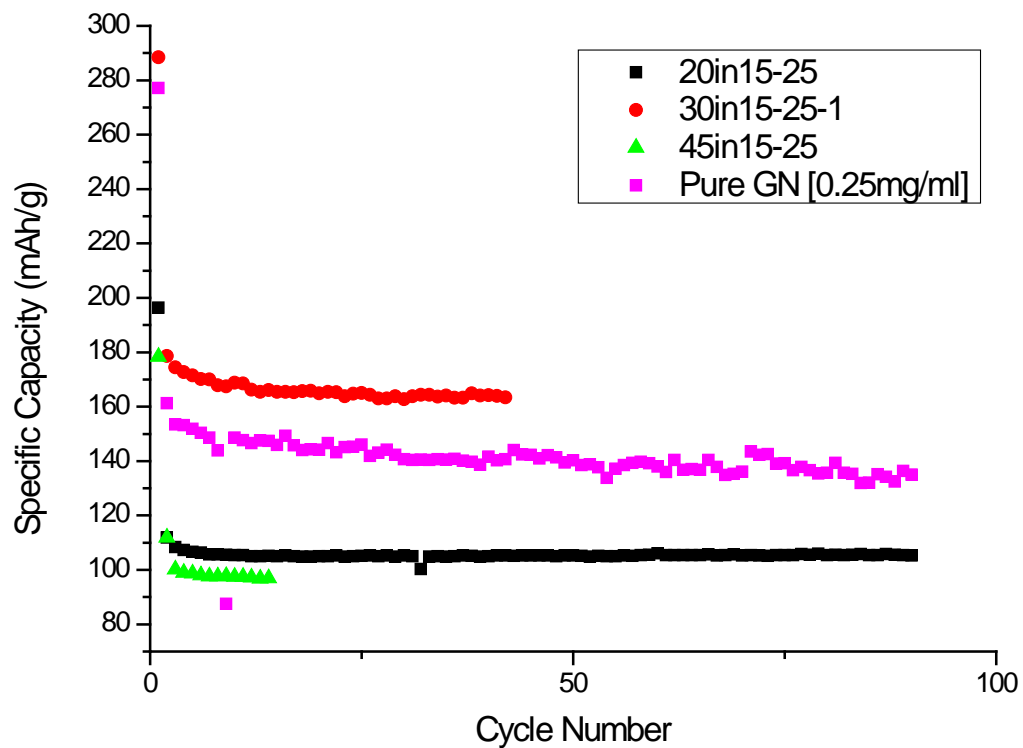






## EDS

Element	Weight%	Atomic%
O K	20.25	38.38
Na K	13.08	17.26
Al K	1.32	1.49
Si K	2.27	2.45
S K	2.57	2.43
Ti K	58.47	37.02
Cu K	2.05	0.98
Totals	100.00	





# Conclusions

- **Composites paper**
  - The stability and specific capacity of the cycling performance has been improved.
  - The amount of LTO in the system affect the battery performance in a non-linear way.
- **Outlook**
  - Possibility of fabricating other composites paper using GN as matrix;
  - The interaction between the matrix and additive materials;
  - The mechanism of Li-ion intercalation during charge & discharge.

**Thank You!**