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研究獎學金
Research Scholarship

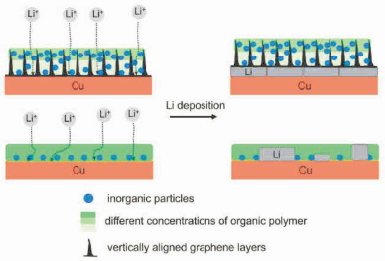
The Microwave Plasma Torch Chemical Vapor Deposition Fabrication of Graphene Layers on Copper Foils for Facilitating Uniform Lithium Deposition

國立清華大學 化學工程學系 博士班四年級 古皓宇
指導教授：胡啟章教授

國立清華大學
NATIONAL TSING HUA UNIVERSITY

LABORATORY OF ELECTROCHEMISTRY & ADVANCED MATERIALS

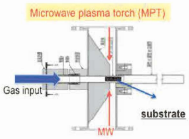
研究重點



The utilization of vertically aligned graphene, grown via microwave plasma torch chemical vapor deposition (MPTCVD), on copper (Cu) foil is investigated for its application in the "zero-excess" lithium metal batteries (ZELMBs), or the so-called anode-free lithium metal batteries. The graphene layers combining high surface area and defect concentration significantly enhance the affinity of Cu foils with the electrolyte. The vertically aligned structure of graphene layers facilitates efficient reduction of NO_3^- and $TFSI^-$ but impedes solvent reduction. This leads to a high ratio of inorganic/organic solid electrolyte interface (SEI), enhancing ionic conductivity and reducing electrolyte consumption. The graphene layers contribute to uniform lithium-ion flux, promoting stable lithium deposition and stripping. In cycling tests for Li@Cu//LFP LMBs (Li@Cu: Li-pre-deposited-Cu, N/P = 1), the cell using the G-Cu substrate shows high-capacity retention of 76.7% after 300 cycles, whereas the cell with an unmodified substrate exhibits only 46.7% retention. A detailed analysis of the electrochemical lithium plating/stripping behavior is conducted via a three-electrode system in this work.

研究成果

◆Experiment



Electrolytes :
1 M LiTFSI in DOL/DME (1/1 by vol.) with 2 wt% $LiNO_3$

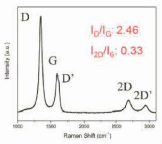
Separator :
Commercial Polyethylene (PE) : 20 μm

Electrodes :
Bare Li
Bare Cu
G-Cu
$LiFePO_4$ with mass loading of 2 mAh/cm²

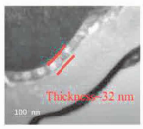
	G-MPTCVD
Power (W)	1100
Temperature (℃)	450
C_2H_2 (Sccm)	2.5
Time (mn.)	6

◆Material Characterization (graphene)

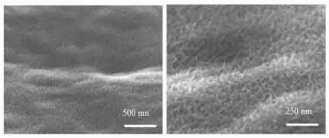
Raman



TEM



SEM



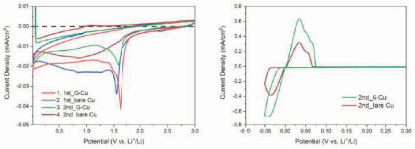
Highly defective and vertically-aligned graphene layers on Cu

Contact Angle

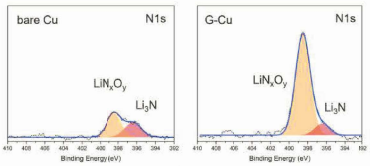
bare Cu G-Cu

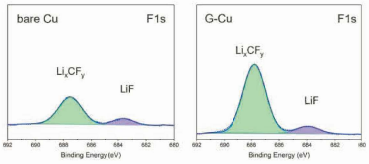
◆SEI Characterization

Cyclic Voltammetry



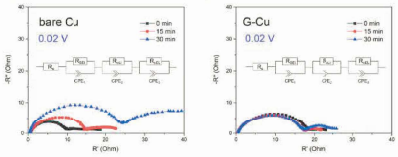
XPS after SEI Formation



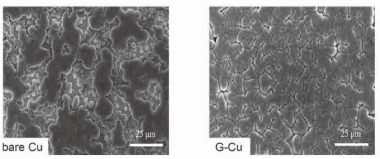


◆Li Deposits Evolution

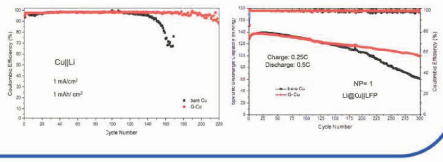
Electrochemical Impedance Spectroscopy



SEM of Li deposits on Cu foils



◆Cycling Performance



研究生活及心得

非常榮幸我的研究成果能夠得到中技社的肯定。對於我而言，做研究就像是在黑暗的路上摸索，雖然能夠享受探索未知的樂趣，但更多時候是要面對徬徨的恐懼，因此在研究生活上我要特別感謝我的指導教授胡啟章老師，給予我高度的自由能夠去研究我自己所感興趣的題目，也在我遇到難題的時候不惜花費大量時間與我一起討論解決，並支持我的各種未來規劃。另外要感謝我的實驗室朋友們，在我反覆熬夜進行實驗，不斷失敗挫折時給我各種鼓勵。也要謝謝我的家人朋友對我一路上的支持與幫助。最後要再次感謝中技社給我的這份鼓勵，未來我會繼續精進，以期對社會有所貢獻。