ABSTRACT

The focus of my work is to find the possibility of synthesizing cheap materials by simple approaches for high performance energy storage devices. Li-ion batteries and electrochemical capacitor are considered two important future energy storage systems. Copper and cuprous oxide is chosen as electrode materials for accomplishing this purpose and synthesized by simple and cost-effective approaches. In developing Li-ion battery anode material, uniform and monodispersed with tunable sized Cu_2O nanocubes were synthesized by a low-temperature in-situ nucleation aqueous chemical reduction. The nanocubes with an edge length of approximately 80 nm used as an anode exhibit excellent lithium storage behavior. In the development of electrochemical capacitor electrode, Cu@Ni$(OH)_2$ nanobelts were fabricated by two aluminum-driven spontaneous electrochemical depositing on carbon/aluminum electrodes. The CuNB acts as a three dimension nanosized current collector for fast electron transport. The Cu@Ni$(OH)_2$ NBs function as pseudocapacitive electrodes, which exhibit a high specific capacitance and a remarkable rate performance. Both of these two studies show a possible electrode material for next generation high-energy and high-power energy storage devices.

ABSTRACT (in Chinese)

本本工作是關於理想的儲能裝置內部電極的開發，我嘗試去找出便宜、製成簡易並且高性能的材料。在進來的研究中，鋰離子電池(Li-ion batteries)和超級電容器(supercapacitor)是兩種最重要的儲能裝置。鋰離子電池表現出高能量(specific energy)而超級電容器表現出高功率(specific power)。金屬銅及氧化亞銅(cuprous oxide)在此被選為研究對象由於產量豐富、價格便宜且容易製備。在鋰離子電池陽極材料的開發，我運用一個快速且簡易並在低溫下進行化學還原法並控制其及時成核的數目(in-situ nucleation)來制備小於 100 奈米的氧化亞銅方塊(nanocube)並能控制其大小。其中，邊長為 80 奈米的樣品表現出優良的鋰離子電池表現。而在超級電容器電極材料的開發，我利用兩次鋁金屬(aluminum)的自發性氧化反應在碳電極上成長出具核殼結構的銅-氫氧化鎳奈米帶($Cu@Ni(OH)_2$ nanobelts)，利用核心奈米銅帶的導電性和結構作為集電器(current collector)來提供快速導電。這樣的核殼奈米帶展現出極高的贗電容值(pseudocapacitance)並維持高速充放電的特性(rate capability)。這兩個工作都成功的發展出次世代儲能裝置可能的電極材料，同時具有高能量和高功率的特性。