# 224th ECS Meeting

## Symposium B8: Intercalation Compounds for Rechargeable Batteries

### Investigation on Lithium Storage Properties of Solvothermal-synthesized Pyrite $FeS_2$ Nanocubes

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Lithium ion battery (LIB) is one of the most widely used forms of rechargeable batteries in today's consumer portable electronics, due mainly to its high energy density and good cycling performance. These properties, coupled with growing attention on renewable energies and environmental sustainability, have led to search for better battery materials that can increase the energy storage, improve the reliability and, yet, reduce the cost of LIBs. Iron sulfides have been used in the battery field for a long time, in particular as electrode material in thermal and lithium primary batteries due to its high theoretical capacity of 890 $mAhg^{-1}$, non-toxicity, earth abundance and low cost. However, iron sulfides are known to react irreversibly with lithium at ambient temperature, hence limiting its use in secondary LIBs. This work investigates the use of pyrite $FeS_2$ as electrode material for rechargeable LIB application. Nanostructuring of the material has been done to alleviate the problem of poor cycling performance and capacity retention of the $FeS_2$ electrode. Nanomaterials have a shorter lithium ion diffusion length than its bulk counterparts, thus giving better rate capability. Additionally, anode materials with unique morphologies have been chemically synthesized by different research groups and were demonstrated to exhibit better capacity retention. Therefore, in this work, pyrite $FeS_2$ nanocubes of about 100nm were synthesized using a simple, one-step solvothermal method. Time-dependent characterization was done to understand the formation mechanism of the nanocubes and it was found that the precursors first react to form sheet-like amorphous $Fe_{1-x}S$ which upon further heating transforms into pyrite $FeS_2$ nanocubes. The lithium storage properties of the as-synthesized $FeS_2$ nanocubes are characterized and found to exhibit a stable cycling performance with a discharge capacity of $555mAhg^{-1}$ after 50 charge/discharge cycles at a high current density of $1Ag^{-1}$. Even at a higher current density of $5Ag^{-1}$, the pyrite $FeS_2$ electrode still managed to achieve a stable discharge capacity of about $220mAhg^{-1}$. Ex-situ analysis of the pyrite $FeS_2$ electrode charged and discharged for different cycles was done to investigate and understand the excellent performance exhibited by the pyrite $FeS_2$ nanocubes.

**Keywords** Lithium ion batteries; Solvothermal; $FeS_2$; Pyrite