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# Synthesis of $FeCl_3$-Graphite Composite from Vein Graphite via Solvothermal Method for Lithium-Ion Rechargeable Battery Applications

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Natural vein graphite is a good crystalline material with high natural purity and is used for advanced applications. Natural vein graphite has been identified as a cost effective source to produce anode material in Lithium-ion Rechargeable Batteries (LIBs). However, the electrochemical performance of anode material prepared from vein graphite has to improve further for practical LIB applications. This study focuses on synthesizing Ferric Chloride-Graphite Intercalation Compound ($FeCl_3$-GIC) via solvothermal method to enhance the Li-ion intercalation. Anhydrous Ferric chloride was used as an intercalant into graphite layers via solvothermal method at 400 $^{\circ}C$ for 12 hours by using 50 mL autoclave. The X-Ray Diffraction patterns show the characteristic behavior of the graphite intercalation compound. Moreover, weaker peaks corresponding to the $Fe_2O_3$ and $FeCl_3$ could also be observed in the XRD pattern indicating the existence of secondary minor phases of $Fe_2O_3$ and $FeCl_3$ in the GICs. Scanning Electron Microscopy images evidenced for the smooth surface morphology of graphite particles after the treatment. Half-cells were assembled using the electrode fabricated from the synthesized material and Li counter electrode in an argon-filled glovebox. It shows a high specific capacity of 378 mA h $g^{-1}$, which is little higher than the theoretical capacity (372 mA h $g^{-1}$ for $LiC_6$) during its first discharge. However, there is a high capacity loss after 25 cycles. The fading nature of this assembled battery could be due to the detrimental effect of $Fe_2O_3$ and unreacted $FeCl_3$. This could be minimized by carrying out the solvothermal treatment in a vacuum environment by eliminating the $O_2$ present inside the autoclave chamber. By doing this, the formation of $Fe_2O_3$ could be minimized and as the chamber pressure increases, the ability of $FeCl_3$ molecules to be intercalated into the graphite layers could be enhanced.

*Keywords:* Vein graphite, Solvothermal process, $FeCl_3$-GIC, Lithium-ion rechargeable battery