FINAL REPORT – EXECUTIVE SUMMARY

Project Number: R-035-044
Recipient: Institute for Energy Studies
Award Amount: $238,366
Total Project Costs: $486,239

Goal of Project:

The overall goal of this project is to develop a low-cost, reproducible, and environmentally benign synthetic procedure for LFP/G (Lithium iron phosphate/graphene) to be used as cathode materials for LIBs (Lithium-ion-batteries) at pilot-scale (10 tons/year). The ultimate goal is to produce the LFP/G at large scale and its target market is the large battery packs for energy storage to support renewable energy generation. The anticipated specific capacity of 150 mAh/g represents a 15% improvement over current technology. Rate capability, low temperature and cycling stability of the LFP/G are also expected to be improved simultaneously.

Significant Findings:

1) A low-cost procedure for extracting and purifying humic acid from ND leonardite was developed, and the humic acid shows high purity, low ash content (~1%), and low metallic impurity.
2) High crystalline purity (>99.5%) of LFP/G was successfully synthesized using the leonardite-derived humic acid as feedstock and the formation and even distribution of graphene coating on the surface of LFP particles was confirmed.
3) The lab-scale LFP/G cathode materials tested on coin-type cells show specific capacities about 150-151 mAh/g, a 15% improvement over commercial products. The pilot-scale materials show no obvious degradation on the specific capacity (146 mAh/g).
4) The estimated price of our LFP/G is $11,164 in contrast to $36,340 by adding external graphene into LFP with only 0.5% usage of graphene, which stands for a 69% of cost reduction.
5) The extraction and purification of humic acid and the production of LFP/G were both successfully tested at a pilot-scale (kilogram-level). Our current pilot-scale facility can produce about 1-2 kg of pure humic acid per batch and a maximum 5 kg of LFP/G per batch. The production capacity will be up to 20 kg/day if a fully integrated continuous mode were developed or multiple production shifts were applied. Most important, the battery performance of the LFP/G by pilot-scale is

similar to the one by lab-scale, which confirms the scalability of the developed synthetic procedure.

Next Steps:

A kilogram-batch LFP/G sample is sent to a cell producer to evaluate the battery performance at large cylindric cells. In spite of the significantly delayed commercialization plan by several major external and internal changes, Clean Republic is still making efforts to move the project towards commercialization.

Benefits of the Project to ND:

This project developed a technology that could open a rapidly expanding high-tech market (Lithium-ion-battery) for abundant and low-cost ND natural resources (Leonardite/lignite). The developed technology increases the competency of ND-based Clean Republic and thus market share of their LIB packs, generating more tax revenue and job opportunities to ND. This project also educated and trained renewable energy work force for ND.