# NCPRE NEWS

September 2017

National Centre for Photovoltaic Research and Education
www.ncpre.iitb.ac.in
A Project of the Ministry of New and Renewable Energy at IIT Bombay


## Silicon Nanoparticles Produced from Sand: A Paradigm Shift in the Economics of High Performance Lithium-Ion Battery Anodes

The Energy Storage group in NCPRE is a **highly dynamic group, bringing together faculty members and students from several Department at IIT Bombay** like Energy Science & Engineering, Materials Science & Metallurgical Engineering, and Chemical Engineering.

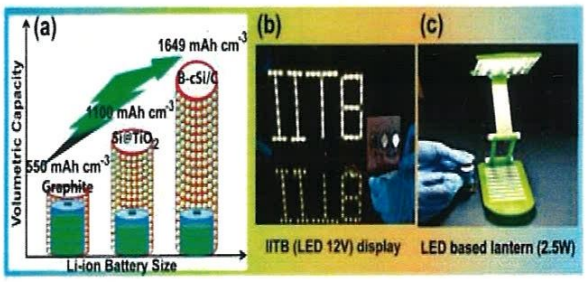
The main deliverables of this Group is to develop: (a) Indigenous, 2.5 Ah LiB battery development in pouch and 18650 cylindrical format in 100 nos.; (b) 0.5 Ah new sodium-ion battery chemistry demonstration; (c) new low-cost electrode materials or fabrication process development; and finally (d) Demonstration of iron-flow battery technology (30 mW/cm$^2$) and scale up.

Several papers from the Energy Storage Group were published and presented recently in various high impact factor international journals and prestigious conferences recently. All these works focused on work done in the area of new electrode materials, their battery performance and various proto type devices.

Silicon is widely considered as the next breakthrough material for the advancement in LiBs. However, there is significant concerns surrounding the commercial potential of silicon. Although the major battery manufacturers and OEMs continue to invest considerable efforts in developing Si-based anodes (**most notably, Panasonic and Tesla who have also going to commercialize their Si-Carbon anodes soon**). There are primary hurdles that need to overcome for great success and one of them are Si-based anodes incorporate nano-scale particles that are "**two-order magnitude**" more expensive that the commercial graphite. **Therefore, the ability of mass-produce Si-nanoparticles from dirt-cheap sand will represent a paradigm shift in the economics of LiBs.** The technology proposed in this section is unique, since it is simultaneously addresses both the aforementioned challenges in one-of-a-kind approach.

The proposed technology relies on extremely cheap precursors (sand) for the synthesis of Si-C composite, while simultaneously incorporating scalable and low cost processing techniques that do not add to cost or infrastructure investment.

In addition, introducing silicon will enable a dramatic improvement in energy density and currently, we have produced Lib cells which can




store 2.5 times energy in volume compare to current technology, making the technology commercially viable, especially for grid storage applications.

**Table 1** below depicts the performance of various battery technologies for grid storage with an estimated comparison with proposed technology. Please note, the cost estimates are based on literature date for expected reduction in electrode coating costs (through aqueous slurries) and materials cost. The cycle life estimate is based on projection from coin cell data, taking into consideration controlled depths of discharge of 50%-80%

| | Cost ($/kWh) | Wh/kg | Cycle life | Wh/L |
|---|---|---|---|---|
| Sodium Ion (Aquion) | 230 | 17 | 3500 | 19.5 |
| Lithium ion (Powerwall 2, Tesla) | 407 | 112 | 5000 | 116 |
| Li-ion (our technology) | 300-400 | 130 | 3000-5000 | 150 |

Now, we filed two patents; US Patent, Application No. 15171226. Filed on 2 June 2016. Indian Patent Appl. No: 201621012185/MUM/2016. In progress, we collaborate with EnerMat Technologies, USA for a trial and applied for an outside funding to process further together or in technology transfer.