Facilities, Equipment and Other Resources (Ju Li)

Li Group Laboratory Space at MIT: ~1500 sq. ft. wet-chemical lab for materials synthesis, characterization and tests.

Fee-based Central Facilities at MIT and Harvard: The Center for Materials Science and Engineering operates four Shared Experimental Facilities (SEFs) on the MIT campus for the analysis and processing of materials. For details see http://mit.edu/cmse/facilities/. We also heavily use Harvard CNS/NNIN facility, for details see http://www.cns.fas.harvard.edu/

Li Group Office Space at MIT: 5 rooms office space total ~900 sq. ft.

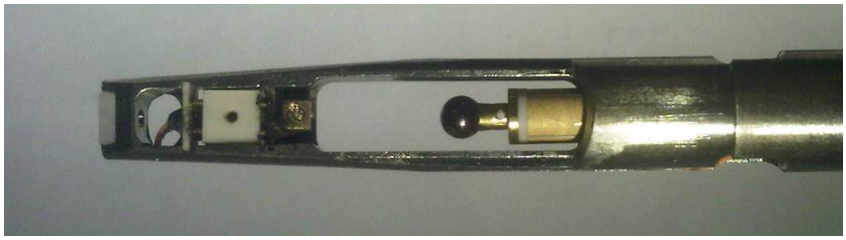
Li Group Local Computing at MIT - We have installed at MIT a 560-core Beowulf cluster (two 2.0GHz Intel Xeon E5-2650 CPUs per node, and eight cores per CPU; each node has 64GB memory and 1000GB disk) connected by Intel QDR InfiniBand High Speed Network, and running the CBeST Cluster Management Toolkit. Currently, VASP, ABINIT, SIESTA, MOPAC, NAMD, GROMACS, Matlab, Mathematica and assorted visualization software are licensed and installed on the above cluster.

Li Group Remote Computing – We have been awarded ~3 million service units (1 service unit = 1 hour of computing on 1 core) on the Stampede cluster at The Extreme Science and Engineering Discovery Environment (XSEDE) supported by the National Science Foundation.

Li Group Laboratory Equipment

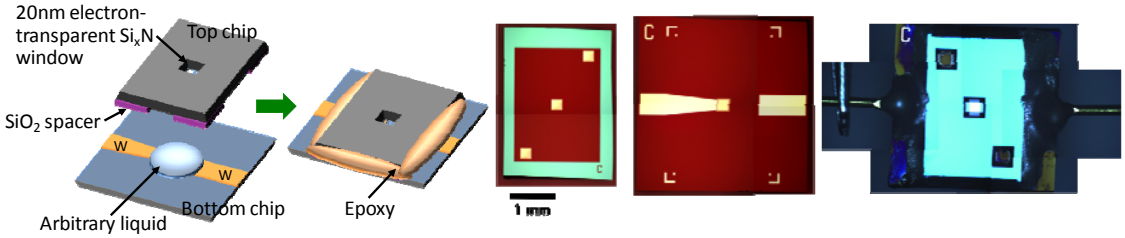
- Quartz/ceramic tube CVD system (Fig. B): Thermo Scientific Lindberg/Blue M Tube Furnace 1500°C, MTI CVD accessories with BWVAC TRP-12 pump. This system is used to synthesize and thermal anneal samples.
- NaBond Electrospinning unit (Fig. C): High voltage power supply (0-50kV), rotating collector (150-6200 rpm), and moving system for spinneret.
- Damon/EC Division centrifuge (Fig. D): 0-4000 rpm.
- VWR Symphony vacuum oven (Fig. E).
- Thermo Scientific Barnstead/Thermolyne Benchtop Muffle Furnace (Fig. F): Maximum temperature 1200°C. 16-segment programmable microprocessor.
- Basic and analytical balances: Mettler-Toledo (accuracy of 0.0001 g)

- Thermo Scientific Super-Nuova Stirring Hot Plate (×2), VWR 5.7L 117V ultrasonic cleaner, vacuum pumps (×2), vacuum filtration systems (×2), desiccator.
- Miscellaneous apparatus and glassware
- Arbin Instruments BT2000 Basic Charge 12-channels battery work station (Fig. G): Model BT2000-LNR-(-2)V-10V-0.5A. BT2000 System Configuration with 3 current ranges; Minimum voltage: -2V; Maximum voltage: 10V; Max charge/discharge current: 0.5A; Current ranges: 0.5A/0.01A/0.0001A; Maximum channel power: 5W. Total channel number: 8ch. Model BT2000-LNR-(-2)V-10V-5A. BT2000 System Configuration with 3 current ranges; Minimum voltage: -2V; Maximum voltage: 10V; Max charge/discharge current: 5A; Current ranges: 5A/0.1A/0.001A; Maximum channel power: 50W. Total channel number: 4ch.
- Gamry Reference 3000 Potentiostat/Galvanostat/ZRA (Fig. H): Maximum current +/-3 A, maximum voltage +/- 32 volts. The Reference 3000 is used for battery, capacitor, or fuel cell development, as well as general electrochemical measurements.
- MBraun Labmaster SP (1250/780) glove box (Fig. I): H2O/O2 pressure lower than 0.1ppm, with gas purifier and antechamber right Labmaster SP. Single user work station. Internal workspace. Dimensions: 1250(W) × 780(D) × 900(H) [mm].
- MTI MSK-110 Hydraulic Crimping Machine (Fig. J): Crimp and package coin cells.
- Nikon LV150 Research Reflected Light Microscope with digital CCD camera (Fig. K): Objectives 20×, 50×, 100×.
- Mettler-Toledo pH meter



- **Nanofactory ST1000 STM-TEM holder**

Li group has purchased and installed Nanofactory ST1000 STM-TEM holder for JEOL TEMs on MIT campus. We have also developed MEMS-based liquid *in situ* TEM holders in collaboration with Norcada, Inc. and environmental TEM tests on Hitachi H-9500 ETEM in collaboration with XJTU-Hitachi High-Technologies R&D Center.



- Li group designed (left), assembled (middle) and tested MEMS liquid confining holders for *in situ* TEM (right).

JEOL 6320FV Field-Emission High-resolution Scanning Electron Microscope

Li group recently installed an ultra-high-resolution scanning electron microscope capable of secondary-electron imaging resolution of less than 1.25 nm when operating at 15kV, and about 2.5nm when operating at 1kV. The magnification can be 25× to 2,000× in LM mode and 500× to 650,000× in HR mode. The cold-cathode field emission gun can provide accelerating voltage from 0.5 to 30 kV. It is fully upgraded to digital and incorporates an image archiving computer. It is also equipped with a back-scatter electron detector and an energy-dispersive x-ray detector from Oxford Instruments.

Glove box for Li-air battery (MBRAUN LABstar Glovebox)

The MBRAUN LABstar Glovebox Workstation is suitable for performing electrochemical measurements with controlled moisture level. This glove box is capable of controlling the moisture to less than 0.1 ppm.

Glove box for electrochemical batter test (MBRAUN Acrylic Glovebox Workstation)

The MBRAUN Acrylic Glovebox Workstation GB 2202 specially designed for electrochemical test from electrode preparation to capacity measurement. There is purging system in inside the glove box which easily allows for the organic vapor evacuation while maintain inert condition, crucial for synthesizing nanostructured electrodes. There are several electrical connections on the side of the glove box, allowing direct characterization of battery capacity within glovebox.