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Experiment Safety Review Form
Review Number: PS-ESR-1-149.1

PRINCIPAL INVESTIGATOR: Kyung-Wan Nam
GROUP: Chemistry, Battery
EXT: 3202 **E-MAIL: knam@bnl.gov** **LIFE NUMBER: 23558**

Project Title: Construction and testing of small lithium and lithium-ion cells
Location(s):
Area(s): 0725-FIRST-1-149
Proposed Start Date and Duration: 10/1/2010 - 1 years

SIGNATURES:

Principal Investigator: Kyung-Wan Nam	**Date: 10/26/2010**
Experiment Review Coordinator: Lori Stiegler	**Date: 10/26/2010**
Reviewer: Christopher Weilandics	**Date: 10/12/2010**
Reviewer: Frank Zafonte	**Date: 10/7/2010**
Reviewer: Lori Stiegler	**Date: 10/26/2010**
Reviewer: Keith Klaus	**Date: 10/12/2010**
Reviewer: Deborah Bauer	**Date: 10/26/2010**
Reviewer: Mary anne Corwin	**Date: 10/20/2010**
Approval: Lori Stiegler	**Date: 10/26/2010**
Review/Approval (ERC) Comments: 10/06/2011 2:31 PM Extended for a year. No change in scope or hazards. 10/26/2010 10:33 AM	
Walkthrough Signature:	**Date:**
Expiration Date (max 1 yr.): 10/26/2012	
FUA Change Required? No	
Fire Rescue Run Card Changes Required? No	
Has a NEPA Review been Performed for this Project? No	
Required Approvals (i.e., IACUC, IBC, etc.):	
Project Termination Acceptance Signature: **Comments:**	**Date:**

I. Define the Scope of the Work

A. Description

Small lithium or lithium-ion cells are constructed. The cell design permits life cycle tests, electrochemical measurements and *in situ* x-ray studies at NSLS. The lithium cells consist of a cathode (a positive electrode consisting of -30 mg of lithium metal oxide such as $LiNiO_2$, 3 mg carbon black and 3 mg poly(vinylidene flouride)), an anode(a negative electrode consisting of 30 mg of lithium foil, and ~200 mL of an electrolyte such as 1 M $LiPF_6$ in a 1:1 ethylene carbonate dimethyl carbonate solvent mixture. The anodes and cathodes are separated by a thin microporous poly(propylene) membrane. The lithium-ion cells are identical except that the anode consists of -20 mg of carbon black and 2 mg of poly(vinylidene flouride) (PVdF). The cathodes and carbon anodes are prepared by slurry casting in the Lab. 361 (Bldg.555) or user institution and transferred to a glove box in Lab. 1-149. All the cell assembly is done in a glove box. The cell is housed either between two 0.125" thick aluminum plates and the assembly is hermetically sealed with gaskets or o-rings, or in coin cell hardware purchased from a commercial vendor. After this the cells are transferred to the atmosphere for electrochemical testing in Lab. 1-149 and x-ray studies at Beam Lines U7A, X7B, X14A, X18A, X18B, X19A or X27C at NSLS. In some cases the charged cells are dismantled in a glove box in Lab. 1-149. The anode or cathode is sealed using Kapton tape in a glove box prior to transfer to the beamline for ex situ x-ray study.

The cells undergo life cycle tests on a battery cycler. The cycler automatically charges and discharges the cells. The output from the cycler is typically less than 1 mA and the maximum voltage is <12 V. Some cells also undergo electrochemical tests on a potentiostat. Some cells will be taken to the beam lines at NSLS to do *in situ* x-ray diffraction (XRD) or x-ray absorption spectroscopy (XAS) experiments. These tests will be done while the cells are being charged and discharged on a cycler.

Equipment manuals or procedures that are controlled documents:

Manual for sample transfer to the glove box.

Manual for operation of battery cycler.

B. Human Performance Factors

Improper use of the glove box may result in contamination of the glove box.

C. Waste Minimization/Pollution Prevention

Cells will be constructed with the minimum amount of materials necessary to get results that can be extrapolated to larger commercial cells. Research involves improving the cell design in order to reduce the amount of lithium foil used. Initially waste from tested cells will be stored in the glove box. Lithium will be stored in hermetically sealed secondary containers. Periodically these wastes will be removed to the satellite area in Lab. 1-149. These will be labeled as hazardous waste. All lithium and lithium containing compounds, in water or in organic solvent, will be treated as hazardous waste. The other wastes will be handled by the normal hazardous waste disposal procedures at the Laboratory. All of the cathode or anode materials used by general users are taken back to the home institution for disposal.

D. Materials Used /Waste Generated

Materials Used	Disposal Method	Amount per Use	Amount per Year	Comments
Lithiated first row transition metal oxides such as LiNiO2, LiMn2O4 and LiNi0.8Co0.2O2	Hazardous	20.00 mg	10.00 g	
Lithium foil	Hazardous	20.00 mg	10.00 g	reacts violently with water-use powder for fighting fire
LiPF6 electrolyte	Hazardous	200.00 ul	20.00 ml	
Poly(vinylidene fluoride)	Hazardous	4.00 mg	200.00 mg	no serious hazard
Carbon black	Industrial	10.00 mg	10.00 g	
4% H2 in Argon	Fugitive	30.00 ft3	0.00	Needed for glove box regeneration 2X/year
		0.00	0.00	

II. Identify and Analyze Hazards Associated with the Work

The following hazards were identified:

Physical Hazards:

- Compressed gases (lecture bottles, cylinders, gas lines) (Area: 0725-FIRST-1-149)

Chemical Hazards:

- Flammable liquids (Area: 0725-FIRST-1-149)
- Highly reactive materials (Area: 0725-FIRST-1-149)
- Nano-material bound in a solid matrix or fixed substrate (Area: 0725-FIRST-1-149)

Ionizing and Non-ionizing Radiation Hazards:

- None

Biological Hazards:

- None

Offsite Work:

- None

Other Issues (Security, Notifications, Community, etc.):

- None

Significant Environmental Aspects

- Any amount of hazardous waste generation (Area: 0725-FIRST-1-149)
- Any amount of industrial waste generation (e.g., oils, vacuum pump oil)
- Production or use of, or waste containing, engineered nanomaterials

III. Develop and Implement Hazard Controls and Assess Risk

A. Physical Hazards, Tasks and Controls

Hazard, Default Controls, Task Specific Info	Risk Level
Hazard: **Compressed gases (lecture bottles, cylinders, gas lines)** **Default Controls:** • Any systems >15psi must be SME Approved • Transport cylinders using a cylinder cart • Secure cylinders to a fixed object/wall • Use regulator, hoses, and components compatible with gas • Use hoses and clamps rated for maximum regulator output or use pressure relief device • Wear safety glasses with side shields when installing/removing/or adjusting regulator • Label piping/tubing	**Negligible (0-20)**

B. Chemical Hazards, Tasks and Controls

Hazard, Default Controls, Task Specific Info	Risk Level
Hazard: **Flammable liquids** **Default Controls:** Use hazardous chemicals controls. Review large quantity storage with Fire Protection Engineer Note location on fire run card and hazard info. placard for storage of solids, greater than 40 pounds; liquids, greater than 5 gallons; gases, greater than 10 pounds **Task Specific Info:** The organic solvents used in the electrolytes are flammable. Solvents, the flammable electrolytes are always used in the glove box filled with Ar gas.	**Negligible (0-20)**
Hazard: **Highly reactive materials**	**Negligible (0-20)**

Default Controls:
Use hazardous chemicals controls plus:
Add to Fire/Rescue Run Cards

Task Specific Info:

lithium metal foils are normally used in the dry box filled with Ar gas. Unwanted lithium metal is reacted with tert-butanol or iso-propanol in hexanes before disposal. Lithium metal foils are normally handled in the absence of air (e.g., in the drybox) or covered by a non-reactive organic solvent.

Any unn-reacted lithium waste must be moved to the 90-day area.

Metal-X fire extinguishing agent is kept inside the lab.

Hazard: **Nano-material bound in a solid matrix or fixed substrate** — **Negligible (0-20)**

Default Controls:
PPE Requirements for Handling: Standard PPE required for the work area. No additional requirements.
Handling Requirements
• No Mechanical abrasion.
• No thermal stresses.
• No etching
Laboratory Posting Requirements - No Posting Requirements
Waste Handling:
• Solids containing nanomaterials which have a potential to be released must NOT be disposed in the regular trash. See SBMS Hazardous Waste Management for more information.
• Collect solid UNP waste in a bag (6 mil thick minimum zip-lock type or J-sealed) or other sealing container (i.e. jar with threaded lid).

• Spell out the chemical name (do not use formulas or trade names) on the RED Hazardous Waste Label.
• The contents line on the label must contain the chemical composition and the word “NANO”
• A second label, in addition to the Red Hazardous Waste Label, is required on the outside other container/bag stating “CONTAINS NANOMATERIALS” see ES&H Coor. or 90-Day area manager for labels.

Task Specific Info:

The cathode and anode electrodes coated on Al or Cu foils may contain nanomaterials. Those electrode are normallyt handled in the golve box and will be hemetically sealed in a coin cell in the glove box for electrochemical tests.

C. Environmental Hazards, Tasks and Controls (include on/off site transportation and products/services)

Hazard, Default Controls, Task Specific Info	Risk Level
Hazard: **Any amount of hazardous waste generation**	**Negligible (0-20)**

Default Controls:
Engineering Controls
• Waste will be accumulated in chemically compatible containers that appropriately contain/protect the waste.
• Waste containers will be closed in a tray (secondary containment) in the Satellite Accumulation Area (SAA).

Administrative Controls
• All hazardous waste containers will have a (red) “Hazardous Waste Label” that has the generator’s name and the chemical contents (trade name/formula not acceptable).
• All waste will be accumulated in closed containers and kept in an established and posted SAA until ready for transfer to the 90-Day Haz Waste Area for pick-up by Waste Management.
• For pick-up by Waste management, complete the Nonradioactive Haz Waste Control Form and consult the 90-Day Area Manager to gain access/transfer the waste to the 90Day Area.

	Training: Hazardous Waste Gen. (HP-RCRIGEN3). PPE: When handling waste materials follow PPE requirements specified for the specific materials. Comply with the SBMS Subject Area: “Hazardous Waste Management”.	
Hazard:	**Any amount of industrial waste generation (e.g., oils, vacuum pump oil)** **Default Controls:** Engineering Controls • Store only compatible wastes together, in suitable containers. • Provide secondary containment for liquid wastes if potential for environmental release exists. • Keep containers closed and secured unless adding waste to container. Administrative Controls • Use a green industrial waste label, with generator’s name and chemical contents (trade name/formula NOT acceptable). Label oils “Used Oil”. • When full, complete and submit a WCF for pick up. The waste may be stored in the 90-day area. Training: Hazardous Waste Generator (HP-RCRIGEN3) Comply with the SBMS Subject Area: “Industrial Waste”.	**Negligible (0-20)**
Hazard:	**Production or use of, or waste containing, engineered nanomaterials** **Default Controls:** • All waste in contact with nanomaterials must be disposed as hazardous waste e.g., (gloves, lab coats, swabs, Kimwipes, blotter paper, beakers, flasks, tape, sample holders). Chemicals containing nanomaterials must NOT be released to the sink or disposed in the regular trash. See SBMS Hazardous Waste Management for more information. • Liquids must be stored in a rigid leak proof container. • Particulates must be stored in a rigid leak proof containers “OR” =/> 6 mil plastic bags. • Spell o **Task Specific Info:** The cathode or anode electrode coated on Al or Cu metal foils used by users may contain nanomaterials. Those electrodes will be taken back to home institution for disposal.	**Negligible (0-20)**

D. Radiation Hazards, Tasks and Controls
None

E. Biological Hazards, Tasks and Controls
None

F. Offsite Work Hazards, Tasks and Controls
None

G. Other Issues (Security, Notifications to Other Organizations, Community Involvement, etc.)
None

H. Recommended Exposure Monitoring

- None

Description or comments:

I. EPHA Determination

Chemical Name	Quantity (lbs, gal)	Location (Bldg/Room#)

IV. Perform Work Within Controls

A. Recommended Training and Medical Surveillance Summary

- NSLS Env Awareness for the SAA (LS-ENV-SAA)
- NSLS R2A2 for Lab Steward (LS-R2A2-LAB-STWD)
- Laboratory Standard (HP-IND-220)
- Hazardous Waste Generator (HP-RCRIGEN3)
- Compressed Gas Safety (TQ-COMPGAS1)
- Nanotechnology for Nano-workers (TQ-NC-HS2)

B. Personnel Training, Qualification, and Authorization List

Employee/Guest Name	Life/Guest#	Dept	Required Training Course(s)	Signed
Kyung-Wan Nam	23558	CO	Compressed Gas Safety (TQ-COMPGAS1) [EXPIRES: 9/20/2014] Laboratory Standard (HP-IND-220) [EXPIRES: 2/24/2012] Hazardous Waste Generator (HP-RCRIGEN3) [EXPIRES: 2/8/2012] NSLS Env Awareness for the SAA (LS-ENV-SAA) [EXPIRES: 12/15/2012] NSLS R2A2 for Lab Steward (LS-R2A2-LAB-STWD) [EXPIRES: 12/15/2011]	
Xiaojian Wang	24034	CO	Compressed Gas Safety (TQ-COMPGAS1) [EXPIRES: 3/18/2013] Laboratory Standard (HP-IND-220) [EXPIRES: 2/23/2013] Hazardous Waste Generator (HP-RCRIGEN3) [EXPIRES: 3/9/2012]	
Xiqian Yu	24648	CO	Compressed Gas Safety (TQ-COMPGAS1) [EXPIRES: 10/31/2013] Laboratory Standard (HP-IND-220) [EXPIRES: 2/23/2013] Hazardous Waste Generator (HP-RCRIGEN3) [EXPIRES: 10/31/2011]	10/28/2010 10:20:46 PM
Enyuan Hu	A8225	CO	Compressed Gas Safety (TQ-COMPGAS1) [EXPIRES: 12/8/2013] Laboratory Standard (HP-IND-220) [EXPIRES: 6/1/2012]	
Xiao-Qing Yang	18129	CO	Laboratory Standard (HP-IND-220) [EXPIRES: 2/23/2013]	10/26/2010 11:56:38 AM
Paul Northrup	N5360	LT	Laboratory Standard (HP-IND-220) [EXPIRES: 9/13/2013]	11/5/2010 1:00:51 PM
Seong min Bak	Z8963	CO	Compressed Gas Safety (TQ-COMPGAS1) [EXPIRES: 11/16/2013] Laboratory Standard (HP-IND-220) [EXPIRES: 11/17/2012] Hazardous Waste Generator (HP-RCRIGEN3) [EXPIRES: 11/16/2011]	2/2/2011 2:21:56 PM

C. Emergency Procedures

Contact the Control Room for any spill or emergencies. Follow Bldg 725 Local Emergency Plan. Metal-X fire extinguising agent may be used in case of lithium foil fire.

D. Transportation

None

E. Notifications

None

F. Termination/Decommissioning

Disposal of hazardous materials, small equipment to excess.

V. Provide Feedback

None

VI. Attachments

Attached Files: