CHEMICAL SAFETY UPDATE

Procedures[1] for Safe Use of Pyrophoric Organolithium Reagents

MAY 2009

Procedures[2] for Safe Use of Pyrophoric Organolithium Reagents

Scope

Storage, transfer and use of organolithium reagents including (but not necessarily limited to):

Alkyls –

- Methyl-d3-lithium, as complex with lithium iodide solution 0.5 M in diethyl ether
- Methyllithium lithium bromide complex solution
- Methyllithium solution purum, ~5% in diethyl ether (~1.6M)
- Methyllithium solution purum, ~1 M in cumene/THF
- Methyllithium solution 3.0 M in diethoxymethane
- Methyllithium solution 1.6 M in diethyl ether
- Ethyllithium solution 0.5 M in benzene/cyclohexane (9:1)
- Isopropyllithium solution 0.7 M in pentane
- Butyllithium solution 2.0 M in cyclohexane
- Butyllithium solution purum, ~2.7 M in heptane
- Butyllithium solution 10.0 M in hexanes
- Butyllithium solution 2.5 M in hexanes
- Butyllithium solution 1.6 M in hexanes
- Butyllithium solution 2.0 M in pentane
- Butyllithium solution ~1.6 M in hexanes
- Butyllithium solution technical, ~2.5 M in toluene
- Isobutyllithium solution technical, ~16% in heptane (~1.7 M)
- sec-Butyllithium solution 1.4 M in cyclohexane
- tert-Butyllithium solution purum, 1.6-3.2 M in heptane
- tert-Butyllithium solution 1.7 M in pentane
- (Trimethylsilyl)methyllithium solution 1.0 M in pentane
- (Trimethylsilyl)methyllithium solution technical, ~1 M in pentane
- Hexyllithium solution 2.3 M in hexane
- 2-(Ethylhexyl)lithium solution 30-35 wt. % in heptane

Alkynyls –

- Lithium acetylide, ethylenediamine complex 90%
- Lithium acetylide, ethylenediamine complex 25 wt. % slurry in toluene
- Lithium (trimethylsilyl)acetylide solution 0.5 M in tetrahydrofuran
- Lithium phenylacetylide solution 1.0 M in tetrahydrofuran

Aryls –

- Phenyllithium solution 1.8 M in di-n-butyl ether

Others –

- 2-Thienyllithium solution 1.0 M in tetrahydrofuran
- Lithium tetramethylcyclopentadienide
- Lithium pentamethylcyclopentadienide

Hazards

Pyrophoric compounds ignite spontaneously when exposed to air. Many organolithium compounds are pyrophoric; they tend to be toxic and are commonly dissolved in flammable solvents. Other potential hazards associated with organolithium compounds include corrositivity, teratogenicity, water reactivity, and are peroxide forming. Additionally, organolithium compounds can cause damage to the liver, kidneys, and central nervous system.

Controlling the Hazards

Due to the extreme hazards of handling pyrophoric organolithium reagents, the Office of Environmental Health and Safety and the Chemical and Environmental Safety Committee require all laboratories that store and use these pyrophoric substances to develop written standard operating procedures for their safe use, storage, and disposal. Prior to handling pyrophoric reagents, all laboratory personnel must receive specific training on safe operating procedures. The training must include:

1. Reading relevant Material Safety Data Sheet (MSDS) and understanding the hazards
2. Wearing proper personal protective equipment
3. Training in proper laboratory technique
4. Minimizing the quantity of pyrophoric reagents used
5. Storing and disposing of the pyrophoric reagent
6. Understanding emergency procedures
7. Discouraging working alone in the laboratory when handling pyrophoric compounds
8. Providing disciplinary actions for employees not following safe procedures

All training must be documented by the laboratory. Refer to Appendix A. The Office of Environmental Health and Safety can provide assistance in developing standard operating procedures and training. Contact your Department Safety Advisor for assistance.

PERSONAL PROTECTIVE EQUIPMENT (PPE)

Eye and Face Protection

- Chemical Splash goggles or safety glasses that meet the ANSI Z.87.1 1989 standard must be worn whenever handling pyrophoric chemicals. Ordinary prescription glasses will NOT provide adequate protection unless they also meet this standard. When there is the potential for splashes, goggles must be worn, and when appropriate, a face shield added.
- A face shield is required any time there is a risk of explosion, large splash hazard or a highly exothermic reaction. All manipulations of pyrophoric chemicals which pose this risk should occur in

a fume hood with the sash in the lowest feasible position. Portable shields, which provide protection to all laboratory occupants, are acceptable.

Skin Protection

- Gloves must be worn when handling pyrophoric chemicals. Nomex ® gloves are recommended with thin mil nitrile gloves under them. Nitrile gloves are combustible but should be adequate for handling most organolithium compounds in general laboratory settings. Refer to Appendix B.
- A flame resistant laboratory coat or coveralls should be worn when using pyrophoric reagents. Flame resistant materials such as flame-retardant treated cotton and Nomex ® provide thermal protection. They can ignite but will not continue to burn after the ignition source is removed. Flame resistance clothing should meet the American Society for Testing and Materials standard, ASTM F2302: Standard Performance Specification for Labeling Protective Clothing as Heat and Flame Resistant. Flame resistant clothing can be purchased from Mission Linen, Fisher Safety and Lab Safety Supply. Refer to Appendix B.
- Clothing made of flammable synthetic materials including acetate, nylon, polyester, polypropylene, and spandex must NOT be worn when handling pyrophoric substances. Fiber blends that contain these materials may be worn only if they meet ASTM F2302: Standard Performance Specification for Labeling Protective Clothing as Heat and Flame Resistant.
- No open toe shoes are allowed.

DESIGNATED AREA

Eyewash

- Suitable facilities for quick drenching or flushing of the eyes should be within 10 seconds travel time for immediate emergency use. Bottle type eyewash stations are not acceptable.

Safety Shower

- A safety or drench shower should be available within 10 seconds travel time where pyrophoric chemicals are used.

Fume Hood

- Many pyrophoric chemicals release noxious or flammable gases and should be handled in a laboratory hood. In addition, some pyrophoric materials are stored under kerosene (or other flammable solvent), therefore the use of a fume hood (or glove box) is required to prevent the release of flammable vapors into the laboratory.

Glove (dry) box

- Glove boxes are an excellent device to control pyrophoric chemicals when inert or dry atmospheres are required.

IMPORTANT STEPS TO FOLLOW

Individual handling pyrophoric reagents in the laboratory should always be with a colleague trained in emergency response procedures. In an emergency, your colleague must be available to assist should an accident occur.

Handling pyrophoric Reagents –

- By using proper syringe techniques, these reagents can be handled safely in the laboratory.

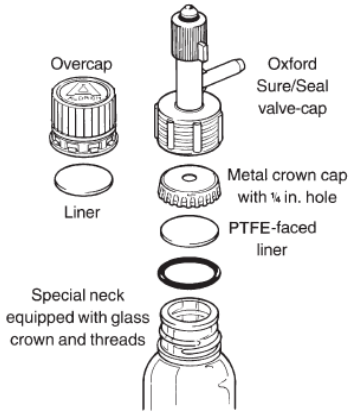

Fig. 1A Sure/Seal components

The Aldrich[3] Sure/Seal™ Packaging System

The Sure/Seal packaging system (**Fig. 1A)** provides a convenient
n d dispensing air-sensitive reagents. The reagent
c ing a syringe or double-tipped needle (16, 18 or 20
g gh the hole in the metal cap. When inserting a
n tum, a layer of silicone or hydrocarbon grease on
t Upon withdrawal of the needle, the small hole that remains in the PTFE liner will not cause the reagent to deteriorate under normal circumstances. However, it is recommended that the plastic cap be replaced after each use and in particular for long-term storage.

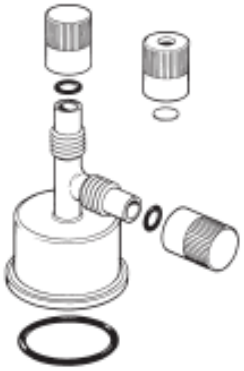

Fig. 1B Sure/Seal septum-inlet transfer adapter

For extended storage of unused reagents, use the solid plastic cap, or equip the bottle with an Oxford Sure/Seal valve cap, or transfer the reagent to a suitable stor

The Sure/Seal septum-in
repeated dispensing is n
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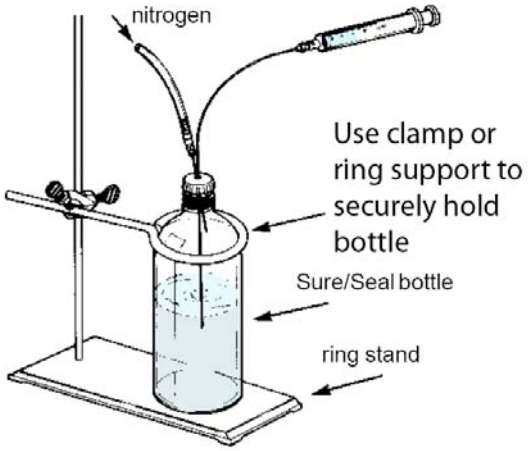

Fig. 2A Filling syringe using nitrogen pressure

Transferring Pyrophoric Reagents with Syringe

- In a fume hood or glove box, clamp the reagent bottle to prevent it from moving
- Clamp/secure the receiving vessel too.
- After flushing the syringe with inert gas, depress the plunger and insert the syringe into the Sure/Seal bottle with the tip of the needle below the level of the liquid
- Secure the syringe so if the plunger blows out of the body it, and the contents will not impact anyone (aim it toward the back of the containment)
- Insert a needle from an inert gas source carefully keeping the tip of the needle above the level of the liquid
- Gently open the inert gas flow control valve to slowly add nitrogen gas into the Sure/Seal bottle.
- This will allow the liquid to slowly fill the syringe (up to 100mL) as shown in **Fig. 2A**. Pulling the plunger causes gas bubbles.

- Let nitrogen pressure push the plunger to reduce bubbles. Excess reagent and entrained bubbles are then forced back into the reagent bottle as shown in **Fig. 2B**.
- The desired volume of reagent in the syringe is quickly transferred to the reaction apparatus by puncturing a rubber septum as illustrated in **Fig. 2C**.

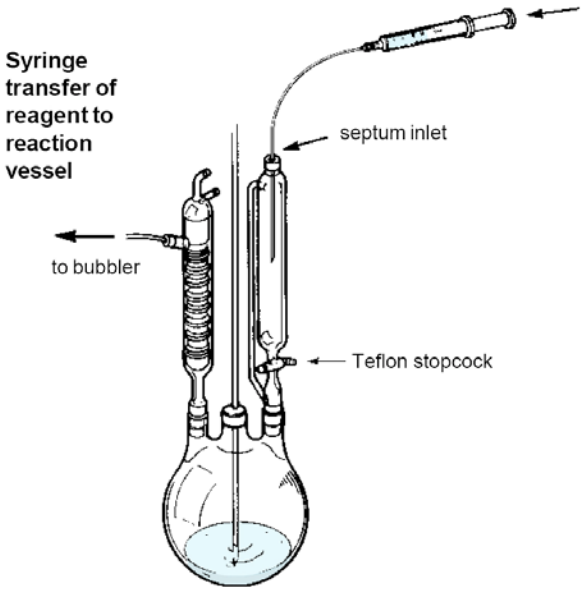

Fig. 2C Syringe transfer of reagent to reaction vessel

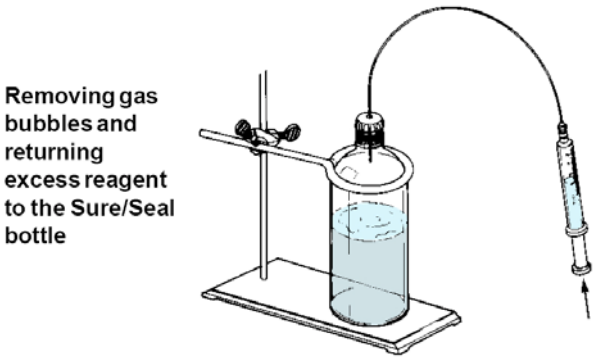

Fig. 2B Removing gas bubbles and returning excess reagent to the Sure/Seal bottle

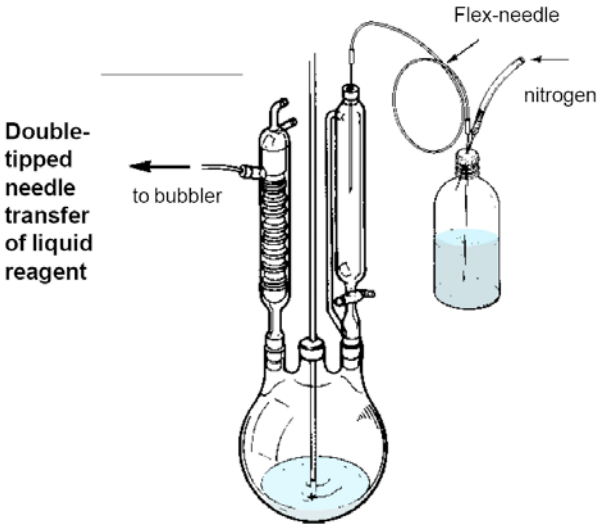

Fig. 3A Double-tipped needle transfer of liquid reagent

Transferring Pyrophoric Reagents with a Double-Tipped Needle

- The double-tipped needle technique is recommended when transferring 50 mL or more.
- Pressurize the Sure/Seal bottle with nitrogen and then insert the double-tipped needle through the septum into the headspace above the reagent. Nitrogen will pass through the needle. Insert the other end through the septum at the calibrated addition funnel on the reaction apparatus. Push the needle into the liquid in the Sure/Seal reagent bottle and transfer the desired volume. Then withdraw the needle to above the liquid level. Allow nitrogen to flush the needle. Remove the needle first from the reaction apparatus and then from the reagent bottle. **(Fig. 3A)**
- For an exact measured transfer, convey from the Sure/Seal bottle to a dry nitrogen flushed graduated cylinder fitted with a double-inlet adapter **(Fig. 3B)**. Transfer the desired quantity and then remove the needle from the Sure/Seal

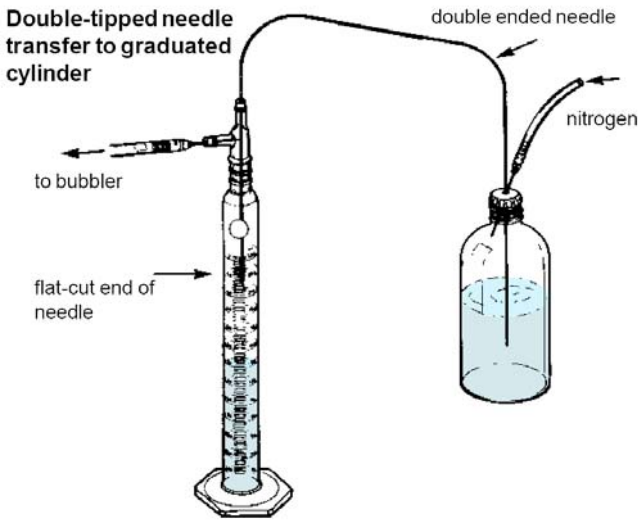

Fig. 3B Double-tipped needle transfer to graduated cylinder

bottle and insert it through the septum on the reaction apparatus. Apply nitrogen pressure as before and the measured quantity of reagent is added to the reaction flask.

- To control flow rate, fit a Luer lock syringe valve between two long needles as shown in **(Fig. 3C)**.

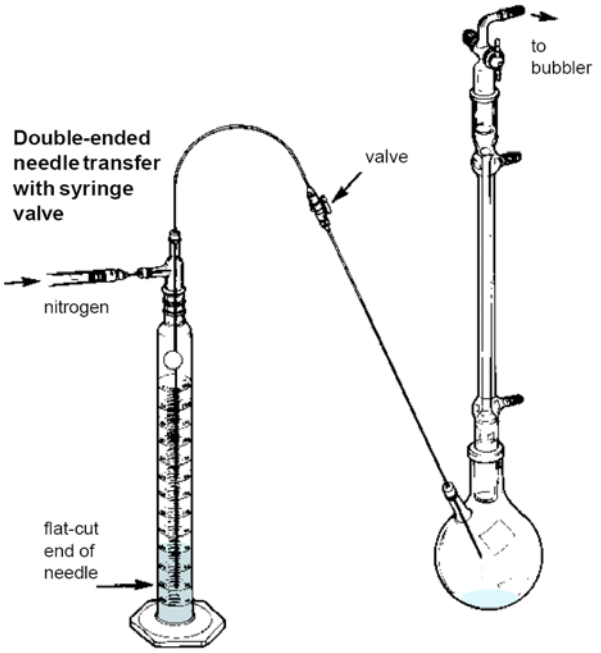

Fig. 3C Double-ended needle transfer with syringe valve

Storage

- Pyrophoric chemicals should be stored under an atmosphere of inert gas or under kerosene as appropriate.
- Avoid areas with heat/flames, oxidizers, and water sources.
- Containers carrying pyrophoric materials must be clearly labeled with the correct chemical name and hazard warning.
- For storage prepare a storage vessel with a septum filled with an inert gas
  - Select a septum that fits snugly into the neck of the vessel
  - Dry any new empty containers thoroughly
  - Insert septum into neck in a way that prevents atmosphere from entering the clean dry (or reagent filled) flask.
  - Insert a needle to vent the flask and quickly inject inert gas through a second needle to maintain a blanket of dry inert gas above the reactive reagent.
  - Once the vessel is fully purged with inert gas, remove the vent needle then the gas line.
- For long-term storage, the septum should be secured with a copper wire (**Fig. 4A**)

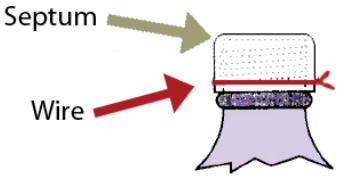

Fig. 4A Septa wired to vessel

- For extra protection a second same-sized septa (sans holes) can be placed over the first (**Fig. 4B**).
- Use parafilm around the outer septa and (obviously) remove the parafilm and outer septa before accessing the reagent through the primary septa

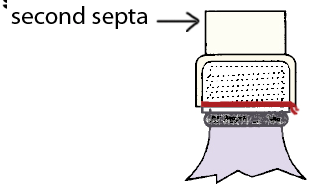

Fig. 4B For long-term storage, use a second septa

Important Steps to Follow

Disposal of Pyrophoric Reagents

- A container with any residue of pyrophoric materials should never be left open to the atmosphere.
- Any unused or unwanted pyrophoric materials must be destroyed at the by transferring the materials to an appropriate three-necked reaction flask. The flask must be equipped with a stirrer, dropping funnel and inert gas inlet for hydrolysis and/or neutralization with adequate cooling.
- The essentially empty container should be rinsed three times with an inert dry solvent such as dry toluene and heptane; this rinse solvent must also be hydrolyzed or neutralized prior to disposal as waste.
- After the container is triple-rinsed, it should be left open in back of a hood or atmosphere at a safe location for at least a week. After the week, the container should then be rinsed 3 times again.

Disposal of Pyrophoric Contaminated Materials

- All materials that are contaminated with pyrophoric chemicals should be disposed as hazardous chemical waste.
- Alert EH&S for any wastes contaminated by pyrophoric chemicals.
- The contaminated waste should not be left overnight in the open laboratory and must be contained in an appropriate container, clearly labeled and disposed according to UCSF Waste Disposal guidelines.

EMERGENCY PROCEDURES

SPILL/ACCIDENT

- Shut off all ignition sources.
- Allow the spilled material to react with atmospheric moisture.
- Use powdered lime to completely smother and to cover any spill that occurs. Keep a container of powdered lime within arm's length when working with a pyrophoric material.
- The recommended fire extinguisher is a standard dry powder (ABC) type. Class D extinguishers are recommended for combustible solid metal fires (e.g., sodium, LAH) but not for organolithium reagents.
- Consider purchasing a fire blanket and keeping it near the working area to quickly extinguish flames on a person.
- In the event of skin contact, immediately wash with soap and water and remove contaminated clothing.
- In case of eye contact, promptly wash with copious amounts of water for 15 min (lifting upper and lower lids occasionally) and obtain medical attention.
- If pyrophoric material/solution is ingested, obtain medical attention immediately.
- If large amounts are inhaled, move person to fresh air and seek medical attention at once.
- Call 9-911 to call Emergency Response Team (ERT). Respiratory protection maybe necessary in the event of a large spill or release in a confined area.

APPENDIX A

LABORATORY TRAINING REGISTRATION FORM

Date: **Time**:

Title: **Safety Training - Use of Pyrophoric Chemicals** **Location:**

Instructor

Last Name	First Name	PI/Supervisor	Department	Signature

Appendix B

Ansell Micro-Touch® Exam-Grade Disposable Nitrile Gloves from Lab Safety Supply

Perfect Fit* Nomex* Flight Gloves from Fisher Safety

Mechanix Wear® Original Nomex™ Mechanix Gloves from Lab Safety Supply

Flame Resistant 100% Cotton Lab Coat from Mission Linen
Treated Cotton Fibers for Flame Protection

Lab Coat HRC1

Product Details | Lot Sizes

Lab Coat HRC1

- HRC1
- Protection: Arc Rating ATPV 7.7 calories/cm^2
- Flame-resistant 7 oz. 100% cotton
- Button-front closure
- Lapel collar, hemmed sleeve ends
- Side vent openings
- Care: Home and Industrial Wash

Replaces KCL2LB

NOMEX Brand IIa Lab Coat from Mission Linen
Synthetic Fabric – Inherent Fibers for Flame Protection

Lab Coat HRC1

Product Details | Lot Sizes

Lab Coat HRC1

- HRC1
- Protection: Arc Rating ATPV 5.7 calories/cm^2

Button front closure. Lapel collar. Hemmed sleeve ends. Side vent openings.
Fabric: Flame resistant, 6 oz. NOMEX® IIIA.
Silhouette: Home wash. Light soil wash.

[1] Created from a variety of resources, principally the Sigma-Aldrich Technical Bulletins and these websites: www.safety.rochester.edu/ih/standops8.html & www.brandeis.edu/ehs/labs/pyrophoric.html
[2] Created from a variety of resources, principally the Sigma-Aldrich Technical Bulletins and these websites: www.safety.rochester.edu/ih/standops8.html & www.brandeis.edu/ehs/labs/pyrophoric.html
[3] Images and advice from Sigma-Aldrich Technical Bulletins AL-134 and AL-164 at: http://www.sigmaaldrich.com/chemistry/aldrich-chemistry/tech-bulletins/tech-bulletin-numbers.html