

Liquid Nitrogen Safety

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Recent Internet postings on the Microscopy listserver indicate paradoxical views on the personal protective equipment (PPE) necessary to handle liquid nitrogen (LN₂) safely. Those views range from full protective gear to, somewhat facetiously, complete nudity. The crux of the paradox is that both extremes have points of validity.

The gist of preventing frostbite or cold injury to the skin is to prevent continuous contact with LN₂. The physics of the Leidenfrost effect (LE) protects the skin from momentary contact or splashes of LN₂. A layer of gas between the LN₂ and the skin prevents significant heat transfer from the skin, stopping damage. The LE does not apply to inadvertent splashes of LN₂ to the cornea. Alternatively, using protective equipment insulates the skin and prevents trapping of the cryogen by allowing the LN₂ to run off.

Safety information and diagrams from Reichert-Jung cryopreparation instrumentation manuals demonstrate the non-trapping concept well. Other cryogen safety recommendations can be found in the CRC Handbook of Laboratory Safety, 3rd edition, pages 315-317 and Handbook of Compressed Gases, 3rd edition, pages 75-79. A local cryogen supplier should also be able to provide safety information. The following is a synthesis of safety recommendations for the use of LN₂.

Full face shields or safety glasses with side guards work well to protect the eyes. Safety goggles or glasses that allows LN₂ to be trapped against the face or eyes are not recommended.

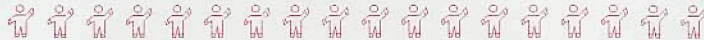
Since TEM users with EDXA systems have to lift a dewar to head level or higher, a full face shield, long sleeve shirt buttoned close to the neck, and cryogen gloves with tight wrists, or loose gloves with a cuff, extending over the wrist of the sleeve is recommended. LN₂ will not be able to dribble or splash from the dewar and become trapped between the shirt and skin. Partially unbuttoned shirts or low-cut blouses should be avoided. Other users can wear short sleeve shirts. Long cuffless trousers should extend over the shoes or boots. Individuals wearing pants tucked into boots, skirts, shorts, or sweats with elastic at the ankle may create a situation where LN₂ can run down the leg or splash into the shoe, become trapped between the shoe and foot, resulting in injury. Those wearing shorts, skirt or sweats are safer working with LN₂ wearing sandals with no heel strap or socks. Wearing sandals, though common and accepted in parts of academia, is an unsafe practice in a laboratory environment.

If one is merely pouring LN₂ from one large dewar into a smaller container, gloves are not suggested so long as all jewelry, watches and bracelets are removed from hands and arms. Cold metal objects are safely handled with a moderately thick potholder. If gloves are used, the fit should be loose so that they may be shed quickly in the event of a spill. Some cryogen gloves have a much tighter fit but also have elastic on the cuff to prevent LN₂ from rolling into the glove and becoming trapped against the skin. Latex, or similar, gloves should not be used while working with LN₂. The latex can freeze rapidly, hold the intense cold against the skin and cause injury.

One liter of LN₂ generates approximately 700 liters of gaseous nitrogen at room temperature. Adequate ventilation is necessary because nitrogen is tasteless and odorless. A spill of 3 L of LN₂ in an 8 m³ (5 X 8 X 9 ft.) elevator causes the oxygen level to decrease from a normal 21% to 17%, a dangerously low level with various physiological effects (12% oxygen causes unconsciousness). The great volume expansion of LN₂ as it warms is the reason any transfer container must allow the constant release of gaseous nitrogen.

Use of LN₂ in a wide mouth container without a cover, if undisturbed for a time, causes differential distillation of pure gas layers over the cryogen. Sparking the oxygen layer in the presence of organic materials or flammables can cause a flash explosion. Such LN₂ containers should be kept loosely covered as much as possible and away from any flammables.

An individual dressed minimally to safely handle LN₂ (in accordance with the LE) would not be safely dressed for other hazards in the lab. Clothing and footwear appropriate for the lab dictate the use of personal protective equipment to shed any spilled or splashed LN₂. While this recommendation will not be welcomed by all, an appropriate safety procedure predicts areas of hazard - and leads even experienced individuals away from the slightest possibility of accident or injury. ■


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Don Grimes, Editor

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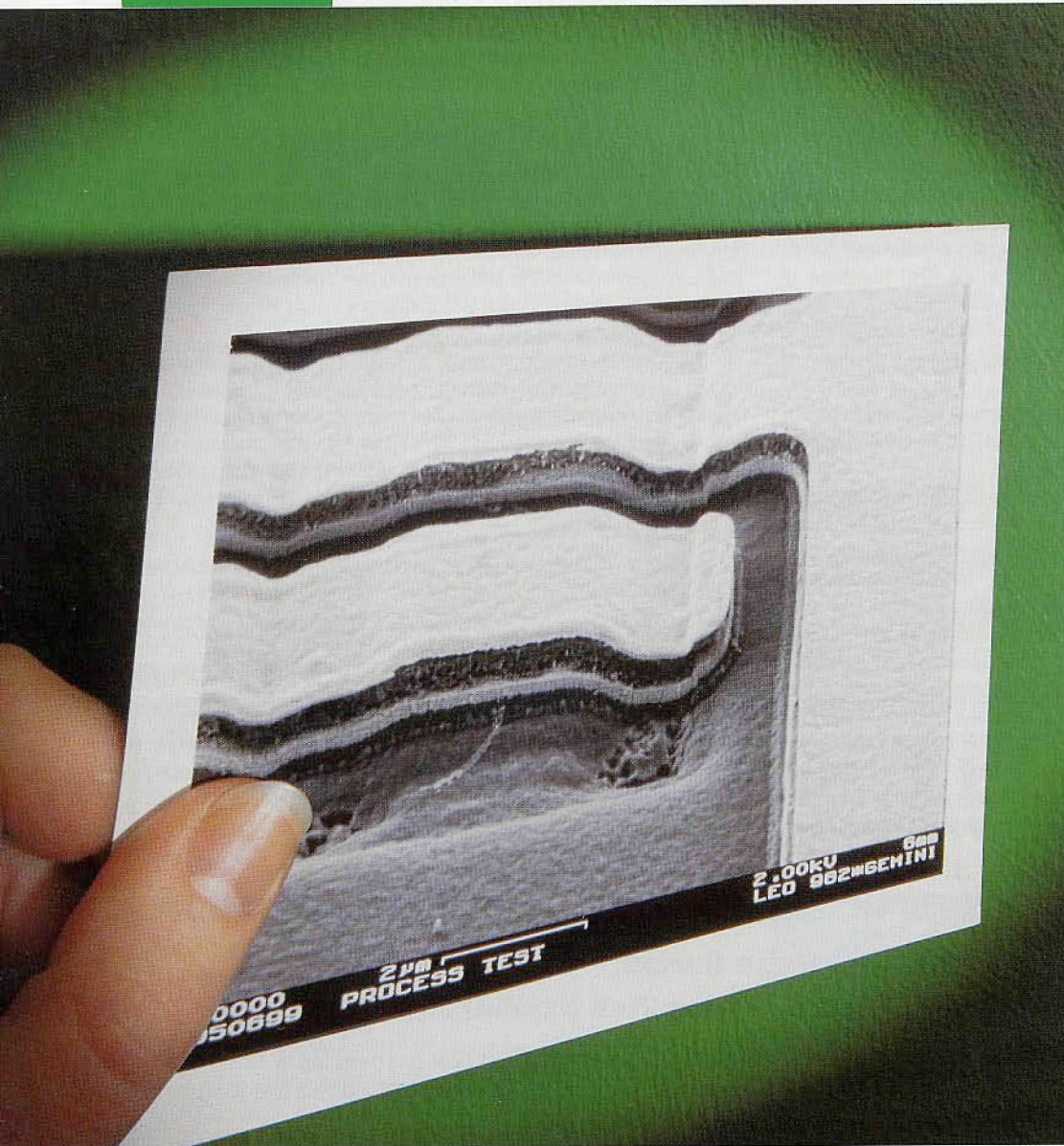
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