

Cryogen Safety

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Liquid Nitrogen

Liquid Ethane and Propane

Summary

Section 1

Liquid Nitrogen

Liquid Nitrogen

Use of Liquid Nitrogen in EM



- ▶ Direct freezing of cryoprotected specimens
- ▶ Primary coolant for immersion freezing
- ▶ Coolant for instrumentation (HPF, cryomicrotome, . . .)
- ▶ Specimen storage
- ▶ Coolant for electron microscopes
- ▶ . . .

Physical Properties

- ▶ Melting point 63 K / --210 °C
- ▶ Boiling point 77 K / --196 °C

- ▶ Cold burns
- ▶ Oxygen deficiency
- ▶ Explosion
- ▶ Liquid oxygen condensation

Liquid Nitrogen

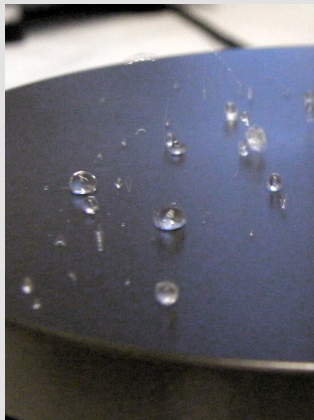
Cold Burns

- ▶ LN₂ used in laboratories is at its boiling point.

Liquid Nitrogen

Cold Burns

- ▶ LN₂ used in laboratories is at its boiling point.
- ▶ LN₂ exhibits Leidenfrost Effect
- ▶ **Temporary** protection by insulating gas layer



Prevention of Cold Burns

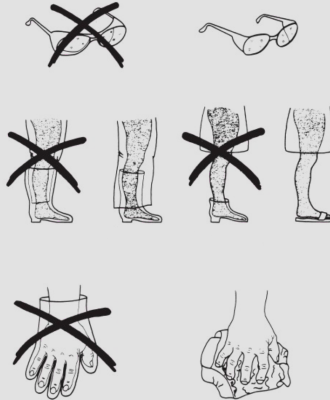
Prevent contact with LN₂ cooled surfaces

Prevent (prolonged) contact with LN₂

Prevent LN₂ from being trapped at your body or being soaked up by your clothes.

Liquid Nitrogen

Prevention of Cold Burns



Leica Microsystems

Liquid Nitrogen

Prevention of Cold Burns



Liquid Nitrogen Prevention of Cold Burns



Liquid Nitrogen

Oxygen Deficiency

1 *l* evaporating LN₂ generates 700 *l* N₂ gas.
N₂ displaces O₂ from room atmosphere.

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- ▶ 21 % -- Atmospheric O₂ level
- ▶ < 18 % -- Decreased physical and mental performance
- ▶ < 11 % -- Risk of unconsciousness, irreversible brain damage, death

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O₂ concentration decreased to 16 %.

Precautions against Oxygen Deficiency

- ▶ Avoid work with large quantities of LN₂ in confined spaces
- ▶ Only work in well ventilated areas
- ▶ Use oxygen concentration monitors with recent calibration
- ▶ Do not work alone



Liquid Nitrogen Explosion

In confined volumes . . .

Liquid Nitrogen Explosion

In confined volumes . . .

. . . evaporating LN₂ quickly builds up pressure.

Example: A tightly closed container 50 % filled with LN₂ will reach 350 bar -- if it can withstand the pressure for so long.

YouTube: "liquid nitrogen bomb"

Liquid Nitrogen

Precautions against Explosion



- ▶ Only transport LN₂ in vessels with a loose lid
- ▶ All pressurised LN₂ containers and lines have to be equipped with pressure relief valves

- ▶ O_2 can condense from the air into LN_2
- ▶ LOx can ignite fires or react with organic materials

Do not store LN_2 for long periods in an uncovered container!

Section 2

Liquid Ethane and Propane

Secondary cryogen for

- ▶ Immersion freezing
- ▶ Self-pressurized rapid freezing

Used slightly above melting point

Liquid Ethane and Propane

Physical Properties



Ethane

- ▶ Melting point 90 K / --183 °C
- ▶ Flash point 138 K / --135 °C
- ▶ Boiling point 185 K / --89 °C

Propane

- ▶ Melting point 86 K / --188 °C
- ▶ Flash point 169 K / --104 °C
- ▶ Boiling point 231 K / --42 °C

Risks

- ▶ Cold burns
- ▶ Explosion

Liquid Ethane and Propane

Cold Burns

No Leidenfrost effect!

Direct contact with

- ▶ Specimen
- ▶ Skin
- ▶ Eyes

Liquid Ethane and Propane Explosion

Above flash point ($-135\text{ }^{\circ}\text{C}$ for ethane), ignitable mixtures can form in air.

- ▶ Burn liquefied cryogen under controlled conditions
- ▶ Allow liquefied cryogen to evaporate in a chemical hood

Section 3

Summary

Summary

Before Working with Cryogenics

- ▶ Understand (!) the risks
- ▶ Familiarize yourself with local safety regulations and follow them

Recommended reading:


- ▶ [Leica Microsystems: Safety Instructions Liquid Nitrogen \(PDF\)](#)

Thank you for your attention.

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Solutions for Electron Microscopy


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