Activity Hazard Document No. 3273

Experimental Endstation in High Harmonic Generation Laser Laboratory

Reference Copy printed: 10/20/2008. Please See AHD database for official copy

Location of Work: 002-0458
Date of Preparation: October 20, 2008
Division: Chemical Sciences
Principal Investigator: Ali Belkacem x7778
Work Leader(s):
Notes:

Description of Activity:

This AHD covers the use of an experimental vacuum chamber end station in room 2-458. The vacuum system contains a gas jet and a gas cell; this AHD covers the hazard associated with the gases used for experiments in this room. A high harmonic laser beam, generated in room 2-460A, interacts with the gases during the experiments; the alignment, use, and safe handling of this laser is covered in AHD 2107.

The vacuum system is a beam line for the purpose of producing laser-generated High Harmonic radiation and performing experiments using the resulting photons. It consists of several vacuum chambers connected by beam tubes or intervening differentially pumped regions. The residual gas pressure in most of this system will generally be kept at pressures below 10-2 torr. There are two places of external gas inlet in the system: the high harmonic gas cell for laser harmonic generation, and the experiment gas jet in the experimental chamber for experiments.

The high harmonic gas cell will be filled with nonhazardous gases only.

The experiment gas jet is a pulsed supersonic jet directed into and through the experimental chamber, which is pumped by a turbomolecular pump on the other side of the chamber. The jet may be used in effusive instead of supersonic mode. The jet is supplied with gas from a gas cylinder outside of the vacuum chamber.

The experiment gas jet will mainly be operated using nonhazardous gases, such as noble gases or N2. For hazardous or toxic gases, we will use gas cabinets to house gas cylinders, or use sufficiently small volume cylinders when applicable, to reduce the hazard associated with possible gas leaks. Exhaust lines from pumps on the vacuum system will be appropriately vented to building exhaust.

This AHD will be reauthorized annually or whenever new significant hazards are introduced.

This AHD lists only the significant hazards associated with this activity. Significant hazards are those which; are elevated from a technical activity that requires specialized training and experience beyond that of a normal practitioner to conduct safety; and the risk of exposure to the hazards is sufficient to require that the hazard be mitigated.

This AHD will be reauthorized annually or whenever new significant hazards are introduced.

Identification of Hazards

Schedule: Compressed Gas - Flammable, Oxidizer

1) Description of Gas System

a) List of Gases

A file listing the current gases and hazard analysis for components in AHD 3273 is available in the "Upload Files" section of this AHD. In the file Tables listed as follows are included.

Table 1. Gas Cylinder (Complete for ALL gases including inert gases).

Table 2. Gas Hazards (Complete for Flammable or Pyrophoric gases only).

Table 3. Accidental Release Analysis (Complete for Flammable or Pyrophoric gases only).

Table 4. Gas Hazards (Complete for Health Hazard gases only).

Table 5. Accidental Release Analysis (Complete for Health Hazard gases only)

Updates to these files will be made whenever new components are introduced. The Appendix located file will reflect current operating conditions. If the changes made in the updated file content do not result in any increase in hazard, no new authorization will be necessary. Determination of changing hazard level by a new item will be made by considering whether the hazard rating -HIGH or EXTREME- is sufficient to mandate a complete reauthorization.

b) Description of Hazard

The primary hazard in this setup is the accidental release of the supply gas for the experimental gas jet into the room. There are two possible release scenarios: Leaks from the gas supply line to the gas jet, leaks from the vacuum system pump exhaust.

Overpressure of the vacuum system with the jet gas is not considered a significant hazard, since the gas jet intrinsically contains a small (0.5mm) fixed aperture that limits the gas flow rate into the vacuum system even if the pulsed gas valve is artificially held open continuously. This gas volume can easily be pumped by the vacuum pumps on the system. Furthermore, the vacuum and cylinder gas pressure will be periodically monitored by the experimenters.

Specific information on carbon monoxide (CO):

Carbon monoxide is a colorless gas. To the human senses it is invisible. Carbon monoxide is a byproduct of combustion and will appear naturally in any situation where burning has taken place. Carbon monoxide is a toxic asphyxiant, meaning it reduces the oxygen transport properties of the blood. It reacts with the hemoglobin in the blood forming carboxyhemoglobin which prevents the hemoglobin from transferring oxygen. Low PPM doses of carbon monoxide can cause headaches and dizziness. If the victim is removed to fresh air no permanent damages will result. High doses can be fatal.

Specific information on acetylene (C_2H_2):

Acetylene is a highly flammable, but non-toxic gas, although it is an asphyxiant. It is a colorless gas with a strong garlic odor. It produces a very hot flame (over 3000°C or 5400°F) when combined with oxygen. Mixtures with air containing between 3% and 82% acetylene are explosive on ignition.

Acetylene can explode if the pressure of the gas exceeds about 100 kPa (≈14.5 psi) as a gas or when in liquid or solid form. It is shipped and stored dissolved in acetone or dimethylformamide (DMF), contained in a metal cylinder with porous filling. These containers must be stored upright. Do not open acetylene valves more than 1½ turns. Avoid impact against container.

All acetylene piped systems and associated equipment must be grounded. Never use copper piping for acetylene service, only steel or wrought iron pipe should be used. Under certain conditions, acetylene can react with copper, silver, and mercury to form acetylides, compounds which can act as ignition sources. Brasses containing less than 65% copper in the alloy and certain nickel alloys are suitable for acetylene service under normal conditions. Acetylene can react explosively when combined with oxygen and other oxidizers including all halogens and halogen compounds.

Some elastomers such as Nitrile, Viton, and Silicon are not recommended since they can exhibit volume loss.

Specific information on ethylene (C_2H_4):

Ethylene is a highly flammable, but non-toxic gas, and a simple asphyxiant. Use with grounded equipment. Ethylene is non-corrosive and may be used with any common structural material.

2) Controls

a) Mitigation of Hazards

The experimental gas jet will primarily be operated using nonhazardous gases. In this case, no special hazard mitigation beyond standard safe gas handling procedures will be necessary.

If hazardous (toxic or flammable) gases are used, we will use the following mitigation procedures:

1. Gas supply:

   The preferred approach will be to use the minimum size gas cylinder necessary for the experiment, and if possible to use a gas cabinet regardless of cylinder size.
   Gas cylinders with sufficiently small volume may be used without a gas cabinet, as long as the total used gas volume is below the limits allowed for the used gas (see table 1a in Appendix). This reduces the maximum possible exposed gas volume.

   If larger gas cylinders are used, a gas cabinet will be used to contain the cylinders. (The volume restriction on gas cylinder size in section 1a- Appendix, still applies) The cabinets will be vented to building exhaust. The gas line from the gas cabinet to the gas jet input (external to the cabinet) must be leak checked before use, and kept to a minimum practicable length.

2. Gas exhaust:

   Exhaust lines from pumps connected to the vacuum system will be vented to building exhaust.

   The experiment must not be run unattended when hazardous gases are used, and the gas cylinder valve must be closed when the experimenter leaves the room. The gas pressure in the vacuum system will be periodically checked for system integrity.

b) Personal Protective Equipment

No personal protective measures beyond standard lab safe gas handling procedures are necessary for protection against the gas hazards. Refer to AHD 2107 for a discussion of laser protective eyewear in this experiment..

c) Hazardous Material Handling

The gas cylinders with hazardous gases will only be opened after proper mounting, and connection to a leak checked gas delivery system. All gases will be handled using the standard laboratory safe gas handling procedures.

Used gas cylinders will be returned to the vendor if possible. If cylinders containing hazardous gases are non-returnable, contact EH&S for proper disposal procedures.

3) Waste

Hazardous waste will not be generated during this project.

4) Emergency Procedures

If exposure to carbon monoxide (CO) should occur, leave the room and get to fresh air immediately. Dial x7911 for emergency. Notify emergency/rescue workers of the potential hazard.

5) **Maintenance**

The gas cabinet, if used, will be installed according to guidelines outlined in ALS procedure BL 08-23, and its associated checklist. This procedure is available at http://alsintra.lbl.gov/procedures/procedures.htm. However, parts of the ALS procedure that refer to ESS procedures and to specific ALS procedures will not be applicable to the gas cabinet installation and operation at this location. A checklist is attached to this AHD.

In the case of hazardous gas use, transport lines from the gas cabinet to the gas jet will be leak checked every time the section of the line external to the gas cabinet has been modified or disconnected.

Authorization Signoffs

Name	Role	Signoff Date
Ali Belkacem	Division Director (Designee)	04/03/2008
David Rodgers	Review Team Lead	04/03/2008
Jerome Bucher	CH Division Safety Coordinator	04/03/2008
Ali Belkacem	Principal Investigator	04/03/2008

User Signoffs

For detailed training information, see AHD web application.

Name	User Type	Access Type	Tasks	Training Status	Signoff Date
van Tilborg	Authorized User	Fully Authorized		Complete	07/31/2008
Hidehito Adaniya	Authorized User	Fully Authorized		Complete	07/31/2008
Thomas Allison	Authorized User	Fully Authorized		Complete	04/04/2008
Sun Lee	Authorized User	Fully Authorized		Complete	08/05/2008
Travis Wright	Authorized User	Fully Authorized		Complete	07/31/2008
Byoung-Ick Cho	Authorized User	Task Specific	Allowed to enter the lab, even while experiments are ongoing in the lab. Allowed to perform work on empty optical table such as construction, design, and storage. Is not allowed to operate the laser, HHG or vacuum system.	Complete	09/19/2008
Marcus Hertlein	Authorized User	Fully Authorized		Complete	06/04/2008
Thorsten Weber	Authorized User	Fully Authorized		Complete	08/05/2008
Timur Osipov	Authorized User	Fully Authorized		Complete	08/05/2008

By signing off, Users have acknowledged that their participation in the activities described requires that they 1) understand the hazards and controls involved; 2) receive the appropriate training (including On the Job Training) prior to work; and 3) adhere to all appropriate safety procedures during participation.