Local Rules for the Use of the Raman Spectroscopy Lab

Location:

Raman Spectroscopy Lab, Room 82, Ground floor, Cambridge Graphene Centre, Electrical Engineering Annexe, Phone: 01223 (7) 62353

Lab leader	Dr Duhee Yoon Cambridge Graphene Centre Tel: 01223 (7)62392 Email: dy254@cam.ac.uk
Lab deputy	Ms Anna Ott Cambridge Graphene Centre Tel: 01223 (7)62368 Email: ako24@cam.ac.uk
Facilities Manager	Dr Yury Alaverdyan Cambridge Graphene Centre Tel: 01223 (7)62416 Email: facilities@graphene.cam.ac.uk
Issued under the authority of:	Prof. Andrea Ferrari Cambridge Graphene Centre Tel: 01223 (7)48351 Email: acf26@cam.ac.uk
Version and Date:	Version 001 – 10/06/2016

Scope

These local rules cover the general use of the Raman spectroscopy lab in the Cambridge Graphene Centre, including the use of the Raman spectrometers and various lasers for use in the Raman dark room located the research facility area, room 82, ground floor, Cambridge Graphene Centre. They cover the set-up and alignment of the lasers as well as the normal use of the apparatus. They implement the University's laser safety policy at a practical level and form part of the University's duties under Section 2(3) of the Health & Safety at Work Act 1974.

Description

The lasers are used for Raman and PL spectroscopy. The laser beam is delivered by mirrors from the laser to the Raman spectrometer. The beam is focused onto the sample through an objective, which is a part of an optical microscope. The scattered light signal from the sample is collected by the objective and dispersed by optical grating and detected with CCD detector.

Authorised Users

User Classes

All the users of the system are divided into different classes. Prof Andrea Ferrari (e-mail:acf26@eng.cam.ac.uk) is responsible for the system. Class A and A* users can train Class B users and supervise Class C users if Prof Ferrari judges they are fit to do so. He also decides in

which class a prospective user should be, on the basis of their experimental requirements and after consulting with their academic supervisors (if applicable). All the users must complete the log book with a detailed description of the experiments performed. The Raman spectroscopy lab will be locked whenever not in use. The user is responsible for any accident happening. Any user causing any sort of accident or found in breach of any safety or operating procedure can be banned for an indefinite time from system use (and, in any case, not before the user gives a job number to charge any expense occurred).

Class A users
Class A users have full access to the system at any time. They are system managers and guarantee the good working condition of the Raman spectrometer systems. They can remove parts from it, align it, move the optics and perform any non-standard operation. Their names are written on the users' list. When performing non-standard operation, they will wear goggles/lab coat/gloves when necessary, and ultimately is up to their judgement to act in the safest way when performing non-standard operations.

Class B users
Class B users can use the Raman system without supervision. They are allowed to switch the lasers on and off (apart from the water cooled UV Ar-ion laser, unless specially trained) and calibrate the system using the internal Si or other reference samples, but they are FORBIDDEN to perform any system alignment or to modify anything in the setup. They need to see one of the managers if any alignment is necessary. Their names are written in the users' list. Class B users will be trained by an authorised Class A user on how to use the software and take measurements. The target of these instructions is to provide a STANDARD procedure to SAFELY operate the Raman hardware, room interlock and laser.

Class C users
Class C users can use the Raman system without supervision but require Class A or Class B user to switch the lasers on/off and calibrate the system(s). They are FORBIDDEN to perform any system calibration or alignment or to modify anything in the set up. Class C users will be trained by an authorised Class A user on how to use the software and take measurements. The target of these instructions is to provide a STANDARD procedure to SAFELY operate the Raman hardware, room interlock and laser.

Class D users
Class D users can have access to the Raman Spectroscopy Lab only under the supervision of a Class A or Class B users. They can only focus and move the sample under the microscope when set for the white light illumination. They are FORBIDDEN to perform any measurements, system calibration, alignment or modifications to the setup. Regular Class D users' name are written in the users' list.

Training

All subsequent training will be provided by Class A users, who were present at the initial training session, and as thus are qualified users.

The content of any training should include:

- General Health & Safety training for the laboratory (Risk Assessment).
- Specific Health & Safety training regarding laser radiation (Local Rules).
- Precise description of the system arrangement for Raman setup.

- Description of the required cable connections for the Raman setup.
- Description of the correct operating procedures to follow during lasing.
- Description of the software package.
- Precise description of the procedures to be followed during shutdown.

Laser Controlled Area

The Laser Controlled Area has been designated as the Raman dark room, with key control to the laser itself, enclosures, interlocked Raman spectrometer and access to the door controlled by an additional interlock. The code to override the interlock system at the entrance door will be given to trained users, who are allowed to perform measurements themselves, only. In addition to this, a warning beacon, mounted on the wall outside the laboratory, is illuminated during laser operation when the interlock has been switched on.

Procedures

The main procedures that will be carried out with regard to the setup and maintenance of the Raman apparatus are outlined below. The first section concerns the setup for normal operation, with the procedures listed in the sequence in which they should be performed. The second section concerns maintenance, giving approximate timescales for each procedure and names who exactly is responsible/ permitted to execute the task.

Standard Procedures – Normal Operation

1. Entering the room: the entering door lock is controlled by swipe card access. If the warning light for interlock is on, type the entry code in the keypad on the right of the door. You then have 30 seconds to enter room.
2. Make your shoes clean with step on a sticky mat and put on overshoes.
3. Turn on the appropriate Raman PC.
4. Turn on the laser you wish to use.*
5. Turn on the interlock.
6. Start the Raman software on PC.
7. Before starting measurement, please wait for a while for the laser warming up.*
8. Place the Si reference, and check the calibration of Raman spectrometer.
9. If the alignment is not satisfactory, ask Class A users.
10. Place your sample and measure.
11. If using UV laser place the black metal shield around microscope stage to avoid exposure to scattered UV light.
12. When you finish, remove your samples and exit the Raman program.
13. Switch off the laser **
14. Switch off the PC
15. Leaving the room: Press the “PRESS TO EXIT” button on the left door. You have 30 seconds to exit the room. If the Raman systems and all the lasers are off, turn the interlock off and switch off all the lights when you are the last user to leave the lab.

Emergency Shutdown

A red emergency shutdown button is located on the left of the door.
Once it is pressed, one has to release it by rotating it clock-wise and pulling it, in order re-start the system again.

Non –standard Procedures

Changing system operating wavelength and aligning the laser beam. This operation must be performed by only Class A and A* users. Any Class B user needing to work with a wavelength different form the one in use, ask a Class A or A* user. All jewellery must be removed and left outside the room. All other objects that, according to the operator's judgement, may give reflections have to be removed too.
When doing non-standard procedures with the UV laser (UV laser alignment): as few users as possible must be present in the room; the door must be locked as an appropriate sign displayed the door. A face shield, laser safety goggles, and gloves must be worn at all times. To visualise the UV beam, a card with fluorescent paint should be used. When the required operation level is reached, place back any beam enclosure parts if they had been removed and/or remove the interlock override tool and lock the spectrometer.

*Switching on the lasers

a) For the 632.8 nm He-Ne laser, turn the key on the back or power supply of laser to 1. The power LED should be green. Allow at least 20 mins to stabilise.
b) For the 532 nm DPSS laser, turn the key on the back or power supply of laser to 1. The power LED should be green. Allow at least 20 mins to stabilise.
c) For the 785 nm diode laser, turn the key on the back or power supply of laser to 1. The power LED should be green. Allow at least 20 mins to stabilise.
d) For the 325 nm He-Cd laser, turn the key on the back or power supply of laser to 1. Allow at least 20 mins to stabilise.
e) For the air-cooled multi wavelength (457.9 nm, 488 nm and 514.5 nm) Ar-ion laser, turn on the main switch on the back of laser. Turn the key on the remote control connected to the laser to 1 and turn the switch on the remote control to open the laser shutter. Allow at least 20 mins to stabilise.
f) For the water-cooled Ar-Kr ion laser, open the valves for the house water located on the wall (the flow out before the flow in). Turn on the two black power switches (for the laser and chiller) on the wall, and then turn the chiller on and turn to 1 the key of power supply under the optical table. Push the button "on/off" on the remote controller to turn on the laser and set the current to 32 Amps. Allow at least 30 mins to stabilise. After stabilisation, tune the knobs on the back of laser to maximize the laser emission.
g) For the water-cooled UV Ar-ion laser, check if the N_2 gas is flowing through the gas flow meter on the side of laser; the number should be between 1.0 ~1.5 SCFH. If not, check the main valve on the wall. Open the valves for the house water located on the wall (the flow out before the flow in). Turn on the two black power switches (for the laser and chiller) on the wall, and then turn the chiller on and turn to 1 the key of power supply under the optical table. Push the button "on/off" on the remote controller to turn the laser on and set the current to 35 Amps. Allow at least 30 mins to stabilise. After stabilisation, tune the knobs on the front of laser to maximize the laser emission.

** Switching off the lasers

a) For the He-Ne laser (632.8 nm), turn the key on the back to 0 or power supply of laser.
b) For the 532 nm DPSS laser, turn the key on the power supply of laser to 0.
c) For the 785 nm diode laser, turn the key on the power supply of laser to 0.
d) For the 325 nm He-Cd laser, turn the key on the power supply of laser to 0.
e) For the air-cooled multi wavelength (457.9 nm, 488 nm and 514.5 nm) Ar-ion laser, turn the key on the remote control connected to the laser to 0 and use the switch on the remote control to close the switch of shutter. Leave the laser until the air-cooling fan stops (it takes around 5 mins). Once the fan has stopped, turn off the main power switch at the back of laser.

f) For the water-cooled Ar-Kr ion laser, decrease the current to 10 Amps and then push the button "on/off" on the remote controller to turn off the laser. Leave the laser for 5 mins to cool down the laser tube. After that, turn the chiller off and turn to 0 the key of power supply under the optical table. Turn off the two black power switches (for the laser and chiller) on the wall, and close the valves for the house water located on the wall (the flow in before the flow out).

g) For the water-cooled UV Ar-ion laser, decrease the current to 10 Amps and then push the button "on/off" on the remote controller to turn off the laser. Leave the laser for 5 mins to cool down the laser tube. After that, turn the chiller off and turn to 0 the key of power supply under the optical table. Turn off the two black power switches (for the laser and chiller) on the wall, and close the valves for the house water located on the wall (the flow in before the flow out).

Note: The department is not responsible for any accident resulting from a negligent use of the system (i,e. not following the above procedures).

Maintenance

- The cooling-water filter (for the water-cooled Ar-Kr ion laser and UV Ar-ion laser) should be replaced every six months by a trained user (if warning appears on the chiller). It is important that the water used in the system is 1M Ohm·cm (higher purity water will corrode meatal parts, while lower purity will clog the filter).
- The laser head should be re-aligned annually by a qualified users or laser service engineer (Coherent).
- Electrical safety checks should be performed annually by University-trained personnel.

Protection Measure

As stated in the risk assessment, there are certain procedures required for the safe use and maintenance of the Raman apparatus that must be followed at all times. These include:

- Before use, all users must be suitably trained and have attended the University's laser safety course.
- Before use, all visitors must be made aware of the local laser rules and laboratory regulations.
- Before use, the door must be closed and the interlock connected to the laser.
- Before use, the laser-safety warning light must be switched on. These light must also be switched off after use.
- Before use, all reflective jewellery must be removed and stowed in a remote location.
- Before use, it must be ensured that all lights in the laboratory are switched on.
- When connecting the equipment together, all cables must be carefully laid out and tidied away as best as possible, with cable gullies used where appropriate.
- When re-filling the cooling water reservoir, care must be taken to ensure it is correctly sealed.
- During setup, all equipment must be secured to the mounting rails/platforms provided.
- At all times due care and attention must be paid to the local safety rules and risk assessment.
- Beam termination points must be used as close to the imaging area as possible.

For further information please see the laser user manual.

Summary of Hazards

A full description that may be encountered whilst operating the Raman apparatus can be found in the corresponding risk assessment document, which is located in the appendix. However the following information provides a summary of those hazards:

- Direct laser radiation as well as diffuse and specular reflections for a Class IV laser are hazardous and may result in ocular damage, specifically photochemical and thermal retinal injury, and/or skin damage including skin darkening and photosensitive reactions. UV exposure may cause skin cancer.
- Potential electric shock hazard from the high voltage laser power supply unit.
- Any Class IV laser product is a potential fire hazard.
- Potential fire/electric shock hazard as a result of a cooling water spillage/leak.
- If the correct key control is not implemented then there is the possibility that an untrained user could activate the laser. The potential consequences of this scenario include ocular/skin damage, fire and electric shock hazards etc.
- Cables and connectors lying across the laboratory present a possible trip hazard leading to potential bodily harm and/or equipment damage and system downtime.
- Potential fire/explosion hazard due to the presence of the Class IV laser beam interacting with a metallic powder cloud.

Contingency Plan

In the event of an incident/accident the following procedures should be followed:

1. THINK!! The environment may still be hazardous – Exposure to direct Class IV laser radiation and even diffuse/specular reflections can be hazardous to both the eyes and skin, resulting in photochemical and thermal ***retinal*** injury, and skin darkening and photosensitive reactions.
2. Contact one of following people:
   Dr Tim Wilkinson, CAPE Laser Safety Officer, tel: 01223 (7)48353
   Dr Yury Alaverdyan, Cambridge Graphene Centre Facilities Manager, Tel: 01223 (7)62416
   First aid officer, Physics lab 37499
3. Isolate any equipment pending investigation. If ocular exposure has occurred, a thorough investigation into the cause and nature of the exposure must be take place and the findings recorded.
4. If there is a suspected injury to the eye, consult Occupational Health if possible who will make an assessment and arrange an urgent referral as appropriate.
5. If an injury is confirmed, the injured person should see a specialist ophthalmologist preferably within 24 hours of the injury occurring. The injured person must not drive.
6. If the accident occurs outside the normal working hours of Occupational Health, the injured person should attend the nearest Accident and Emergency (Addenbrookes Hospital). Addendbrookes has an eye clinic where a specialist ophthalmologist should be available for consultation. However, if an ophthalmologist is not available within 24 hours of the injury occurring, you should then be referred to the nearest specialist eye hospital, Moorfields, which has experience in dealing with laser wye injuries.
7. In some circumstances the casualty may benefit from reassurance and professional counselling. If in doubt attend the nearest Accident and Emergency (Addenbrookes Hospital).
8. Details of the laser beam should accompany the casualty to hospital, i.e. wavelength, power/energy per pulse and pulse duration.

Addenbrookes Hospital:
Accident and Emergency Department open 24 hours a day.
Address: Hills Road, Cambridge CB2 2QQ
Telephone: 01223 245 151

MoorFields Eye Hospital:

Accident and Emergency Department open 24 hours a day
Address: 162 City Road, London EC1V 2PD
Telephone: 020 7253 3411
Location and direction to the A&E department can be found at the website:
www.moorfields.co.uk/Locations /CityRoad

List of Users in different Class

Class A*:
Prof Andrea C. Ferrari
Service Engineers

Class A:
In the risk assessment of each apparatus.

Class B:
In the risk assessment of each apparatus.

Class C:
In the risk assessment of each apparatus.

Class D:
In the risk assessment of each apparatus.

User Declaration

I have read, understood and agree to work by the rules set out in this document.