Department of Engineering – Risk Assessment

Ref No. B888

Title of project/experiment/activity
Use of BioLogic VSP-300 Potentiostat/Galvanostat with Impedance (BioLogic Potentiostat)

Location of activity	**Start and end dates**
Cambridge Graphene Centre, Ground floor: Energy Storage Lab	01/08/2016 - continuous

Brief description (or attach procedure/protocol)

The potentiostat is a multipurpose instrument used to measure electrical characteristics of electrochemical cells, such as batteries and supercapacitors. The devices are connected to 2, 3, 4, or 5 electrical probes. The system is equipped with 3 channels for simultaneous measurements. and must be used in accordance with the manufacturers instructions.
Various samples can be measured e.g. graphene, 2d materials, metal oxides, etc. (user should refer to personal risk assessments for sample handling).

For the electrochemical characterization, a device is connected to the potentiostat and a procedure is set up for a specific type of measurement. The cycler can operate under a range of conditions, *e.g.*, applying a specified constant voltage and measuring the current flowing through the device, or applying a specified constant current and measuring the resultant change in voltage across the device.

One of the most common measurements performed is galvanostatic charge-discharge measurement. In this experiment, a constant current is applied to the supercapacitor, and the change in voltage across it is measured as it charges.

Cyclic voltammetry is also widely used to analyse a device, in which case a constant scan rate (dV/dt) is applied and the current is measured.

Two of the channels are equipped with a fast-Fourier multi-sine electrochemical impedance spectroscopy (EIS) that has a frequency range from 10 µHz to 7 MHz, linear scan generator with a scan rate up to 1 MV/s and an acquisition time as low as 1 µs, an ultra-low current capability down to 1 pA and a resolution better than 76 aA, and a high current capability up to 2 A with a compliance voltage of ±30 V.

The third channel is equipped with a fast-Fourier multi-sine electrochemical impedance spectroscopy that has a frequency range from 10 µHz to 7 MHz, linear scan rate up to 200 V/s, a minimum current of 10 nA and a resolution of 760 fA, and a maximum current of 500 mA with a compliance voltage of ±12 V.

The appropriate channel and current range is selected before each measurement depending on experimental requirements.

The use of the cycler involves application of potentials and the passage of currents through solutions of electrolytes. They system is computer-controlled. Though the device under measurement is typically enclosed, there are risks associated with the combination of an electrical appliance and a conducting fluid medium. There may be risks associated with the use of conducting metal ion solutions, such as gas formation. Typical devices that are in the form of a coin cell or Swagelok-type cell are sealed from the outside environment with a metallic casing. Separate risk assessments must be carried out for non-enclosed devices or for devices other than a coin cell or a Swagelok-type cell.

Hazard	Effect	Control measures	Residual risk
General hazards in lab	Inhalation of solvents	Wash bottles containing volatile and combustible solvents, such as acetone, ethanol, and isopropanol, are present and used in the lab to clean items or equipment. (Likelihood: 1, Severity: 1) There is appropriate ventilation in place. The solvent will be contained in a wash bottle. Eye protection and lab coat will be worn while in the laboratory. The Energy Storage Lab rules will be followed.	Low risk
Non-insulated contact points	Electric shock	Electric shock due to the presence of non-insulated contact points between instrument and devices, as well as exposed device surfaces, such as a coin cell whose case is made of stainless steel. (Likelihood: 1, Severity: 1) The instrument can only operate within a compliance of ±30 V. The instrument has a safety system which restricts a device from exceeding this voltage limit if it is required to measure or supply above this voltage limit. The safety option will be used during each measurement. Contact with any exposed electrically active areas is avoided once the experiment has been set in motion. Death can result from normal operation/mains voltage of 230 V present inside the instrument's enclosure, capable of causing currents of greater than 30 mA to flow through the body for more than 40 ms. Minor shocks may also cause injury following involuntary muscle contraction. (Likelihood: 1, Severity: 3) As a result, the instrument will not be opened by the user. Only a qualified technician or expert is allowed to open the instrument enclosure.	Low risk
Gas formation	Explosion; Fire	The formation of gases as a by-product of electrochemical reactions in the confined volume of a stainless steel coin cell may cause an explosion and fire. Injury may result from exploded cell component and other debris as well as the possibility of fire and skin or eye injury from the spill or splatter of the cell content. (Likelihood: 1, Severity: 2) Under normal measurement conditions not exceeding ±5 V for a single cell at a pressure of 1 atm at ≤30 °C,	Low risk

		it is unlikely that enough gas will be generated to rupture the device enclosure which is made of a metal casing. The coin cell device or a variant, which is typically 20 mm wide and 3.2 mm thick, requires use of less than 1 mL of electrolyte solution and no more than a couple of mL of the electrolyte under any reasonable circumstances. For electrical, thermal, or mechanical abuse tests, the the cell is intentionally subject to extreme conditions that could raise the likelihood of excessive gas formation; and its magnitude depends on the level of the abuse. As such, a separate risk assessment must be conducted for such kinds of measurements.	
Thermal runaway	Explosion; Fire	Exothermic chemical reactions may occur inside a cell under measurement, generating a cascade of reactions. This may heat up the device and or generate gases. Injury may result from exploded cell component and other debris as well as the possibility of fire and skin or eye injury from the spill or splatter of the cell content. Under normal measurement conditions not exceeding ±5 V for a single cell at a pressure of 1 atm at ≤30 °C, it is unlikely that enough gas will be generated to rupture the device enclosure which is made of a metal casing. (Likelihood: 1, Severity: 2) For thermal or mechanical abuse tests, the cell is intentionally subject to extreme conditions that could raise the likelihood of thermal runaway; and its magnitude depends on the level of the abuse. As such, a separate risk assessment must be conducted for such kinds of measurements.	Low risk

Personal Protective Equipment required [*eye/face protection, respiratory protection, gloves, lab coat etc*]

Lab coat and eye protection (safety specs) required in the lab at all times.

Emergency Instructions & First Aid

General advice: Consult a physician. Show this risk assessment to the doctor in attendance.

Any special monitoring required [*e.g. hearing test, vibration monitoring, health surveillance*]

Further control measures required? If yes, list with actions.

In the case of equipment malfunction/failure, the power supply may need to be cut off. Merely closing the control software (EC-Lab) will not terminate the measurements. To cut off power from the instrument, the

power switch is located at the bottom left rear of the instrument.
Biological/Laser/Radiation Approval [*requires relevant Specialist Safety Officer signature and date*] N/A
Out of hours/Lone working Measurements may be done overnight. Once the measurement has been started, the instrument completes the measurements based on the preset procedure. Requires permission from Head of Division.

Signature to confirm that this is a suitable and sufficient assessment of risk and that stated control measures are in place. This risk assessment should be reviewed if additional risks not covered in this assessment are identified or if there is any reason to indicate that the control measures are insufficient.

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Local Safety Coordinator	**Signature** D Hart	**Date** 27/10/16
Departmental Safety Office IAN SLACK	**Signature**	**Date** 9 NOV 2016