

| Title of project/experiment/activity Use of 3d printer polyjet (Projet 3500 HD plus) | | | |
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| Location of activity Cambridge Graphene Centre : Ink Lab | | Start and end dates 24/08/2015 - continuous | |
| Brief description (or attach procedure/protocol) <p>The Projet 3500 HD plus is a commercially made polyjet 3d printer and will be used in accordance with the manufacturer’s instructions after training. It is used to jet small drops of liquid polymer and photo cure the drops of polymer to print objects in 3 dimensions onto a solid platform.</p> <p>Cartridges (bottles) are filled and securely inserted inside the printer and the printer drawer is closed. The printing chamber is closed while printing and thus no curing light is visible to the user. The printed material is solid at room temperature and the cartridges are heated at 65°C prior printing by the printer. The user is not in contact with any liquid material.</p> <p>The printer is enclosed, and includes an interlock to prevent accidental contact with moving parts.</p> <p>At the end of the printing procedure, the platform with the solidified composite part is removed from the printer and the solid part detached from the platform. The solid part composed of cured polymer and wax is then placed in an oven (65°C) to remove the wax acting as supporting material.</p> <p>The cartridge is filled and cleaned in the chemistry lab.</p> | | | |
| Hazard | Effect | Control measures | Residual risk |
| Exposure to Urethane acrylate oligomers and Ethoxylated bisphenol A diacrylate polymer matrix | Irritation to the eyes and skin | The cartridges contain Urethane acrylate oligomers and Ethoxylated bisphenol A diacrylate in a solid state at room temperature. When heated to 65°C by the printer, the cartridge must stay inside the printer’s drawer. Cartridges are safe to be removed when solidified. (Likelihood: 1, Severity: 1) Gloves, eye protection and lab coat must be worn whilst in the laboratory. The Ink Lab rules will be respected. | Low risk |
| General hazards in lab | Inhalation of solvents Exposure to chemicals harmful to health | The possible use of other chemical will be covered by dedicated risks assessments dealing with the preparation of nanomaterials composites and COSSH forms. Gloves, eye protection and lab coat must be worn whilst in the laboratory. The Ink Lab rules will be respected. | Low risk |
| Exposure to UV light | Damage to eyes and skin | The printer has a fully encased UV light project. The printer is fully enclosed and no printing is possible if the door is not closed. (Likelihood: 1, Severity: 2). | Low risk |

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| Mechanical: The printer has moving parts leading to potential pinch points. | User may trap fingers. Mechanical damage to equipment | The printer must be used with the security doors closed. (Likelihood: 1, Severity: 1). | Low risk |
| Electric shock | Shock to user, damage to equipment | Do not get outer parts of the printer wet (Likelihood: 1, Severity: 1) | Low risk |

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

Lab coat, gloves (purple nitrile) and eye protection (safety specs) required in the lab at all times

Emergency Instructions & First Aid

Spillage:

Cartridges are filled in the Chemistry Lab (material is brought at 65°C to be liquid) and is solidified inside the cartridge. No leakage is thus expected from the cartridge. If any spillage is observed, it will be small quantity (few ml) and can be dealt with using a clean room wipes.

Fire:

In case of fire, the fire alarm should be sounded and fire service called. If safe to do so, the fire may be extinguished using an extinguisher containing carbon dioxide, located in the corridor outside the laboratory.

First aid:

General advice: Consult a physician. Show this safety data sheet to the doctor in attendance.

If inhaled: If breathed in, move person into fresh air. If not breathing, give artificial respiration. Consult a physician.

In case of skin contact: Take off contaminated clothing and shoes immediately. Wash off with soap and plenty of water. Take victim immediately to hospital. Consult a physician.

In case of eye contact: Rinse thoroughly with plenty of water for at least 15 minutes and consult a physician.

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

No



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

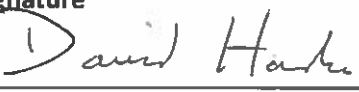

Waste Disposal Procedures: Cartridges are emptied into suitable non-chlorinated waste containers prior to cleaning. Cartridge emptying is performed in the fume cupboard in the Chemistry Lab.

In the case of equipment malfunction/failure: shutdown instrument from plug socket.



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| <p>Biological/Laser/Radiation Approval [requires relevant Specialist Safety Officer signature and date] N/A</p> |
| <p>Out of hours/Lone working The system can be left running unattended and overnight. While printing unattended an „Attention running equipment / Keep away“ notice should be displayed. People working around the printer have to make sure they won't disconnect the printer from the main power. <i>Requires overnight running/out of hours permit from Head of Division</i></p> |

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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| <p>Name of Assessor Panagiotis Karagiannidis Email: pk412@cam.ac.uk</p> | <p>Signature </p> | <p>Date 31/08/2016</p> |
| <p>Name of Supervisor Prof A.C. Ferrari Email: acf26@cam.ac.uk</p> | <p>Signature </p> | <p>Date 2/9/16</p> |

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| <p>Local Safety Coordinator</p> | <p>Signature </p> | <p>Date 2/11/16</p> |
| <p>Departmental Safety Office IAN SLACK</p> | <p>Signature </p> | <p>Date 9 NOV 2016</p> |

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| <p>Title of project/experiment/activity</p> <p>Use of 3d printer polyjet (Projet 3500 HD plus)</p> |
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| Additional Users | Signature | Date |
|-------------------|--|----------|
| YUE LIZH |  | 5/9/16 |
| Yuanlong Shuo | Yuanlong Shuo | 05/09/16 |
| FRANCESCO TORRESI | FRANCESCO TORRESI | 5/9/16 |
| Stephen Hodge |  | 5/9/16 |
| LUCIA LOMBARDI | Lucia Lombardi | 5/9/16 |

Signatures to confirm that risk assessment has been read and understood.

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| Title of project/experiment/activity Acrylate polymers. | |
| Location of activity Cambridge Graphene Centre : Chemistry/Ink Lab | Assessment Reference |
| Brief description (or attach procedure/protocol) See Use of 3d printer SLA (Projet 1200) and Use of 3d printer polyjet (Projet 3500 HD plus) risk assessment and nanomaterial composite preparation risk assessment. | |
| Chemical <i>Biological Agent</i> | Hazard and Work Place Exposure Limits (WEL) |
| Triethylene glycol diacrylate | Causes skin irritation. <u>May cause an allergic skin reaction.</u> Causes serious eye irritation. Exposure limits: LD50 Oral - rat - 813 mg/kg Muscle weakness, Ataxia, Changes in structure or function of salivary glands. LD50 Dermal - rabbit - > 3,000 mg/kg |
| Tricyclodecane dimethanol diacrylate | Causes skin irritation. Causes serious eye irritation. May cause respiratory irritation. Toxic to aquatic life with long lasting effects. No exposure limits |
| Phenylbis (2,4,6-trimethyl benzoyl)- phosphine oxide | <u>May cause an allergic skin reaction.</u> May cause long lasting harmful effects to aquatic life. No exposure limits |
| Urethane acrylate oligomers | Eyes: Can cause irritation consisting of redness, swelling and pain. Skin: Can cause irritation or other allergic reactions, including redness and/or swelling. Inhalation: Inhalation can cause respiratory irritation. Ingestion: Ingestion can cause nausea, diarrhea and/or stomach pain. Chronic: Can cause an allergic skin reaction with repeated or prolonged exposure consisting of redness, swelling and/or rash (urticaria). No exposure limits |
| Ethoxylated bisphenol A diacrylate | Causes skin irritation. <u>May cause an allergic skin reaction.</u> Causes serious eye irritation. May cause respiratory irritation. No exposure limits |
| | Causes skin irritation. |

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| Tripropyleneglycol diacrylate | <p><u>May cause an allergic skin reaction.</u> Causes serious eye irritation. May cause respiratory irritation. Toxic to aquatic life with long lasting effects.</p> <p>No exposure limits</p> |
| Poly (Methyl methacrylate) | <p>Low toxicity under normal conditions of handling and use</p> <p>No exposure limits</p> |
| Toluene (PMMA pellets may contain ≤2.0% toluene) | <p>Flammable liquids Skin irritation Reproductive toxicity Specific target organ toxicity - single exposure Central nervous system Specific target organ toxicity - repeated exposure Aspiration hazard</p> <p>TWA 50ppm STEL 100ppm</p> |
| Tetra(ethylene glycol) diacrylate | <p>Harmful if swallowed. Causes severe skin burns and eye damage. Contains no substances with occupational exposure limit values.</p> |
| Methyl methacrylate / n-Butyl methacrylate, methacrylic acid | <p>Low toxicity under normal conditions of handling and use</p> |
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| <p>Control Measures [<i>Fume Cupboard, glove box, safety cabinet, local exhaust ventilation</i>]</p> <p>Prepare solutions containing acrylate in a solvent fume cupboard in the Chemistry lab. After the composites have been prepared they can be taken into the ink lab into a sealed container for use on commercial equipment equipped with exhaust is required.</p> <p>Keep the solution containing polymers and monomers in a tight sealing container and open only in well ventilated laboratory (chemistry or ink lab).</p> | |
| <p>Flammables and explosives</p> <p><i>Is there a substance used or formed that might give rise to a fire or explosion?</i> No</p> <p><i>If yes, list control measures.</i></p> | |

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A more detailed risk assessment will be required if the lower explosive limit is reached during leak or spillage.

Personal Protective Equipment [*Lab coat/overalls, gloves, eye/hearing/respiratory protection*]

Gloves, eye protection and lab coat must be worn whilst in the laboratory.

Monitoring [*Chemical, gas, oxygen depletion etc.*]

Not required.

Health surveillance required [*E.g. Carcinogen, mutagen, toxic to reproduction, sensitizer*]

Not required.

Storage

Triethylene glycol diacrylate and Tricyclodecane dimethanol diacrylate : Recommended storage temperature: 2 - 8 °C

Phenylbis (2,4,6-trimethyl benzoyl)- phosphine oxide, Urethane acrylate oligomers, Ethoxylated bisphenol A diacrylate, Tripropyleneglycol diacrylate : Store in cool and dry place. Keep container tightly closed in a dry and well-ventilated place.

Other acrylates: Store in cool place. Keep container tightly closed in a dry and well-ventilated place. Containers which are opened must be carefully resealed and kept upright to prevent leakage. Keep away from heat and sources of ignition.

Tetra(ethylene glycol) diacrylate must be stored away from UV light.

Waste disposal [*Contractor, chlorinated, non-chlorinated, non-hazardous aqueous, general waste*]

All the wastes must be disposed in the appropriate disposal, most likely non-chlorinated wastes but if chlorinated solvent are use, the waste will go in the chlorinated wastes.

Emergency Procedure

In event of contact with eyes or skin immediately flush with copious amounts of water for at least 15 minutes after removing contaminated clothing. Call Reception for first aider. Inform Departmental Safety Office.

In case of SPILLAGE:

Soak up with inert absorbent material and dispose of as hazardous waste. Keep in suitable, closed containers for disposal.

In case of FIRE:

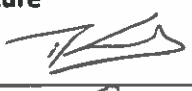

Use water spray, alcohol-resistant foam, dry chemical or carbon dioxide.

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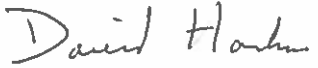

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| <p>First Aid</p> <p>General advice Consult a physician. Show this safety data sheet to the doctor in attendance.</p> <p>If inhaled If breathed in, move person into fresh air. If not breathing, give artificial respiration. Consult a physician.</p> <p>In case of skin contact Wash off with soap and plenty of water. Consult a physician.</p> <p>In case of eye contact Rinse thoroughly with plenty of water for at least 15 minutes and consult a physician.</p> <p>If swallowed Never give anything by mouth to an unconscious person. Rinse mouth with water. Consult a physician.</p> |
| <p>Out of hours/lone working</p> <p>Out of hours/lone working permitted if authorised by Supervisor. <i>Permission from Head of Division is required.</i></p> |

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| <p>Assessment Summary</p> <p>Gloves, eye protection and lab coat must be worn when handling the polymer listed above.</p> |
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Signature to confirm that this is a suitable and sufficient assessment of risk and that stated control measures are in place and will be reviewed.

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| <p>Assessor Dr. Panagiotis Karagiannidis Email: pk412@cam.ac.uk</p> | <p>Signature </p> | <p>Date 26/08/2016</p> |
| <p>Name of Supervisor Prof A.C. Ferrari Email: acf26@cam.ac.uk</p> | <p>Signature </p> | <p>Date 2/9/16</p> |

Reviewed by:

| | | |
|---|---|---|
| <p>Local Safety Co-ordinator</p> | <p>Signature </p> | <p>Date 21/11/16</p> |
| <p>Departmental Safety Officer IAN SLACK</p> | <p>Signature </p> | <p>Date 29 NOV 2016</p> |