GeSiM BioScaffolder Printer Q&A's

Instrument Manufacturer: GeSiM (based in Germany; http://www.gesim.de/en/bioscaffolder/)

Instrument Supplier / Distributor in UK/Ireland: Analytik Ltd (www.analytik.co.uk)

*** What is the maximum number of different materials you can print at once?**

The BioScaffolder 3.1 printer is a versatile and flexible bio-printer featuring four independent Z-drives; three exist for cartridge/extruder dispensing to allow simultaneous printing to build up scaffolds of different materials. The Z-drives can print different materials without changing cartridges. The fourth Z-axes is reserved for the piezoelectric pipetting system and/or Z-sensor.

*** What materials can be printed and what temperatures can the cartridges be heated to?**

The BioScaffolder 3.1 printer can print a variety of pasty materials (hydrogels and biopolymers e.g. collagen, alginate, bone cement paste, polymer paste etc.) and thermoplastics/polymers with temperatures up to 120°C with standard disposable cartridges and for higher temperatures up to 250°C, a piston based metal extruder is available. The piezoelectric micro-pipetting system is used for dispensing pico- and nano-litre spotting of cells, proteins and curing/hardening substances on certain coordinates within a scaffold structure. Printing heads can be optionally added for dispensing larger droplet volumes e.g. solenoid valve dispensers (50nl droplet size) and highly viscous materials e.g. third party adhesive dispensers (PICOxMOD and DELO-DOT dosage heads).

*** We are interested with the piezoelectric pipetting option. Please explain.**

The BioScaffolder printer has an unique piezoelectric pipetting option which allows non-contact dispensing of small volumes of drops (60-500 pico-litres droplet volume) typically of cell suspensions or protein solutions on predefined coordinates of a bio-scaffold layer immediately after printing of this layer. The piezoelectric tip aspirates from standard 96/384 well plates. Liquid volumes of a few micro-litres work with this system. Also the flexibility of the separate piezoelectric tip allows the application of different cells at selected positions of the scaffolds, difficult to achieve by the cartridge dispenser. The dispensed spots usually have sizes between 50 and 200 microns. They can be placed on a scaffold layer immediately after printing and before the next scaffold layer goes on top.

Thus you can get two different kinds of tools on this machine:

1) Pneumatically actuated cartridges for bulk printing of high viscous materials doing 3D bodies. The cartridge volume is between 10 and 30 ml.

2) Heatable piezoelectric pipettor for applying small amounts of liquids e.g. rare and expensive cells/proteins. The samples are aspired from a micro-well plate so several different proteins/cells can be spotted in the same printing run without having to stop to change tips or cartridges.

Most work in this field is done with researchers mixing up the scaffold material and cells/proteins in order to grow tissues after printing the scaffold structure. In some cases this works but not all scaffold materials accept cells and keep them alive during the printing process. With the GeSiM approach these two steps can be separated to combine high mechanical stability of the (hardened) scaffold structure with a cell friendly environment for tissue growing.

The piezoelectric drive/channel would aspire small volumes (1-5ul) of the cells/proteins from a micro-well plate, move to a stroboscope camera to check the size/shape of the dispensing spots allowing the user to change the dispensing parameters (voltage/frequency) of the piezo tip to fit the sample consistency (viscosity, fluidity, electrical charge etc.) thus providing an optimized and high spotting performance.

*** What is the maximum print area possible with the printer?**

The printable area with BioScaffolder printer is around 23 x 15 cm with height around 8 cm. Structures from small as 1mm can be printed. It is possible to print 3D scaffold structures in to the bottom of a well plate (e.g. for cells on scaffolds/drug assay work).

*** What is the printer resolution and filament nozzle size minimum?**

The typical structure/mesh size is between 100 and 400 microns, depending on the material. It may be possible to achieve 50 microns for example with thermoplastic materials like PCL. GeSiM also now offer smaller strut size (in the range of 10-20um) with melt electrospinning as an additional module on the BioScaffolder printer.

*** What is accuracy and speed of the printer?**

Printer step width/movement accuracy is ±2µm in X/Y and ±10µm in Z direction. Positioning speed is up to 50cm/second. Scaffold printing speed and accuracy is dependent on the dispensing polymer/material.

*** How is a scaffold structure defined and communicated to the printer?**

Printer has a 'Scaffold Generator' software tool for defining cubic and cylindrical structures with all the parameters and material assignment for each individual layer/stand. The scaffold generator allows individual cartridges (with materials) to be assigned to each strut. It also defines printing parameters. Basically the machine reads in the common G-code with GeSiM specific extensions. GeSiM also offer an import function for STL data as an option.

*** What are the printer dimensions?**

BioScaffolder printer dimensions are width 65cm, depth 55cm, height 50cm. It is designed to fit under a fume hood/sterile environment.

*** Are there any specific operating requirements with the printer?**

Printer requires standard UK mains power and pressurised air (up to 8bar) to control extrusion from the cartridges. PC comes with the instrument. The piezoelectric pipetting unit will require deionized water.

*** What other developments and/or add-on modules are available/planned for the printer?**

There is a long and growing list of optional accessories and tools available for complete bio-printing flexibility and to cover all future bioengineering research applications. These include:-

- Cooling/heating of microplates and target holders.
- Melt electrospinning for the printing of tiny/small strut sized (10-20um) thermoplastic structures.
- Core shell for creating inner and outer structure/tube – combine hard and soft materials; print composed strands of different materials, e.g. a soft cell containing core material and a much harder shell material.
- Dedicated UV lamp options on the dispensing head for polymer curing.
- Camera to measure strut dimensions and monitoring purposes.
- Cryo/Peltier cartridge chiller dispenser (4°C) available late 2017 – e.g. for dispensing hydrogels at low temperatures.

*** Does the instrument require an annual preventive maintenance service? Do you have a local UK based company who would support us with installation/training/post sale support?**

The GeSiM printers are very robust instruments and do not generally require an annual service contract, although one is nonetheless available. The preventive maintenance (PM) service can be done by the user but can also be offered by Analytik Ltd. Analytik Ltd are the local representative for GeSiM in UK and Ireland and shall provide both pre-sale and post-sale support for the BioScaffolder printer during the lifetime of the instrument, both for existing, trained users and for new people and projects as they come to use the instrument.

*** Would it be possible to see the printer in action and/or send some of our samples to you for printing trials?**

We strongly encourage for you to send some of your materials for printing tests to GeSiM (offered free of charge) with you even being able to oversee the trials by visiting the GeSiM factory in Dresden, Germany. We are extremely confident of the success of these printing trials. Please let us know of your interest/application and we can connect you directly with the contact at GeSiM to pursue these options.

*** Where can I find further information? How can I get a quote?**

For more information please click here: http://gesim-bioinstruments-microfluidics.com/category/bioscaffolder-en/bioscaffolder-basic-features-en/

A video of the instrument has been placed here: https://www.youtube.com/watch?v=jW-xSMMXF50

For quotes and further information, please contact Analytik Ltd (Hiran Vegad; hiran.vegad@analytik.co.uk; Tel: 07968 536674).