

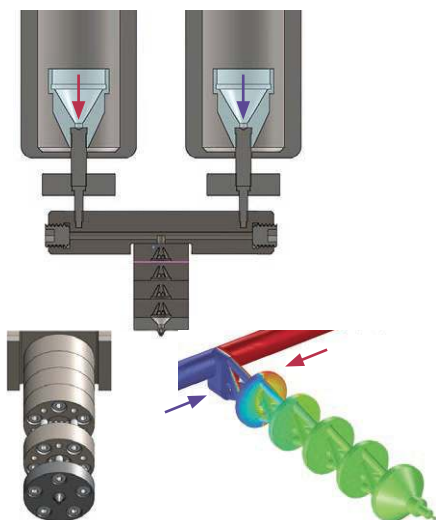
# BioScaffolder Application Note

## New Scaffold Dispensing Tools

### Melt blending printing head (high-temperature mixer/extruder)

Melt compounding of plastics with additives/fillers (e.g. PEOT/PBT + graphene oxide or hydroxyapatite) or printing a gradient of two materials (e.g. bioactive molecules + fillers) in a scaffold require the mixing of two materials. Such a mixing device has been developed in the EU project "FAST" aiming at functionally graded additive manufacturing of implants, e.g. to print bone or cartilage with different properties in the interior and on the surface. It consists of two units of the proven GeSiM high-temperature piston extruder (with all-metal cartridge and two-zone heater) and a static mixer that is usually heated to higher temperatures.

The piston speeds determine the mixing ratio, which can be changed during printing.



Schematic drawing of the ISG cascading mixer ("interfacial surface generator", top), enlarged view of the mixer (bottom left) and finite element simulation of the mixing process (bottom right). A stack of four to five modules is needed for complete mixing.



Mixing extruder (left) and piston extruder for 50 ml cartridges (right) in a BioScaffolder BS4.2

- Temperature: up to 250 °C
- Feasible flow rate: 10 to ca. 200 µl/min
- Dead volume of mixing chamber: 300 µl

Due to its weight, this device can **only** be used in the BS4.2 (see next page).

### Piston extruder for syringes (50 ml or other sizes)

Finally available for BS3.2 and BS4.2: using the same extrusion principle as in the GeSiM high-temperature extruder, we have developed a piston extruder for 50 ml syringes. As it is not cooled, it is mainly intended for hydrogels ("bioinks", with or without cells) that must not or need not be heated.

Standard 50 ml syringes with Luer-Lock nozzle easily snap into the holder and their piston is moved downward for extrusion.

Extrusion can be triggered by compressed air (the standard on the BioScaffolder), but this new system allows that the content of the syringe is sterilized in advance and stays sterile throughout the printing process. The high volume of the syringe makes this system also excellently suitable for the production of bulky structures.

With little refurbishing, syringes of any other size or double syringes can be mounted that e.g. mix cells into bioinks during manufacturing. This is work in progress; detailed information will be provided on our website.

### Atmospheric plasma pen module (expected 2019)

Please visit [www.gesim.de](http://www.gesim.de) frequently for information on the plasma pen that has been integrated into the BioScaffolder for the FAST project. Currently this is an experimental set-up for the plasma treatment of scaffolds, e.g. for sterilization during printing, but it will soon be commercially available.

The plasma pen does not simply generate a spark discharge, but can be used for selective surface modification, as various gases can be mixed into the cold argon plasma.

# BioScaffolder

## New Tools

### Larger platform with linear motor: BS4.2

A bioprinting platform with larger working area has been developed and is ready to ship in 2019. Not only is it sturdier and can carry heavier Z-tools such as the high-temperature mixing extruder (also recommended for the single high-temp. piston extruder), but it also features a linear X-drive for lightning fast operation.

This platform is intended for large-scale production of scaffolds, also in 24/7 operation.

A safety enclosure (similar to the one shown in the small picture) is required for operation and can be ordered from GeSiM.



GeSiM BS4.2 prototype with the new head tools. The system tool area for washing, drying and tip measurement plus MTP holder are now on the right side, leaving room for a large, uncluttered and easily accessible working area.

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