

Precision Fiber Direct Writing Platform

TL-Trinity

Precision Micro/Nanofiber Direct-
Writing Platform

Melt Electrowriting · Near-Field Solution Direct Writing ·
High-Voltage Electrospinning



What Is Continuous Fiber Path Writing?

Place a continuous micro-/nanofiber precisely along a programmed toolpath

to build ordered two- or three-dimensional structures.

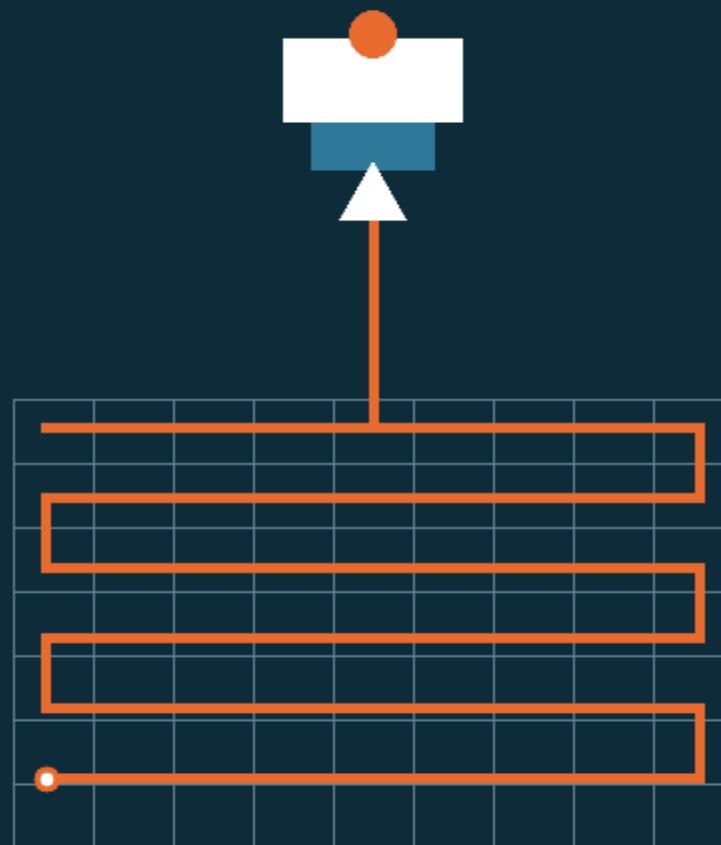
Not point-by-point deposition—
a continuous filament arranged along a
controlled path.

CONTINUOUS FIBER PATH WRITING

Single filament · Programmed trajectory · Ordered structure

CONTINUOUS-FIBER PATH WRITING

ONE FILAMENT / ONE PATH / ORDERED STRUCTURE



CONTINUOUS FIBER — PROGRAMMED PATH —
ORDERED STRUCTURE

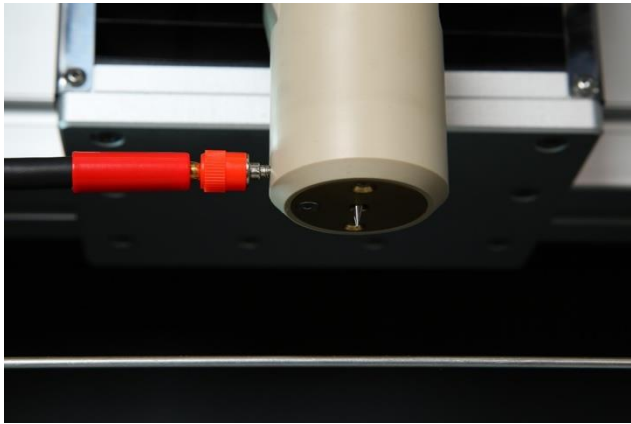
01

02

03

One Platform, Three Fiber-Processing Modes

Reduce duplicate equipment investment and switch rapidly among materials, structures, and processes within one coordinate system.



Melt Electrowriting

Controlled Micrometer Fibers
Ordered 2D/3D Scaffolds

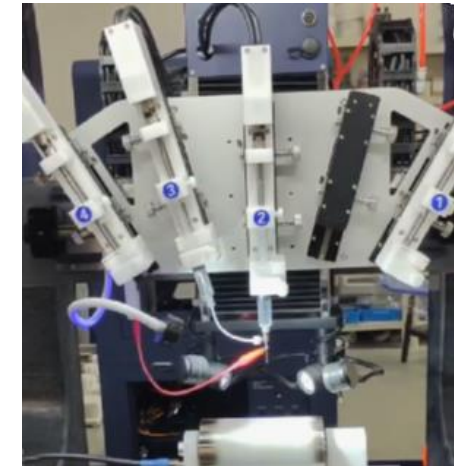
Solvent-Free Processing



Near-Field Solution Direct Writing

Continuous Lines and Curves
Solution and Composite Systems

Precision Low-Flow Delivery



High-Voltage Electrospinning

Nano-/Microfiber Membranes
Multiple Spinnerets and Collectors

Modular Process Configurations

Research Value Beyond an All-in-One Platform

01

Broader Material Window

Modules support materials from low-temperature biomaterials to high-temperature engineering polymers.

02

Multiscale Structures

Spans ordered microfiber scaffolds to random nanofiber membranes.

03

Flexible Sample Geometries

Planar, mandrel, tubular, curved-surface, and multilayer deposition.

04

Programmable Toolpaths

Turns CAD, STL, images, and parametric grids into executable paths.

One Research Platform

Connect material formulation, jet behavior, toolpath design, mechanics, and biological response.

For exploratory research, method development, process-window screening, and shared facilities.

Continuous-Fiber Direct Writing Across Disciplines

01

Tissue Engineering & Regenerative Medicine

Scaffolds for tendon, cartilage, bone, nerve, and muscle research

03

Functional Composites

Piezoelectric, conductive, magnetoresponsive, and particle-reinforced systems

05

Soft Devices & Responsive Materials

Liquid-crystal elastomers, soft actuation, and programmable deformation

02

Tubular Tissues & Implantable Structures

Scaffolds for blood vessels, tracheae, conduits, and fluid regulation

04

Wound Care & Drug Delivery

Porous patches, antimicrobial coatings, and drug-loaded structures

06

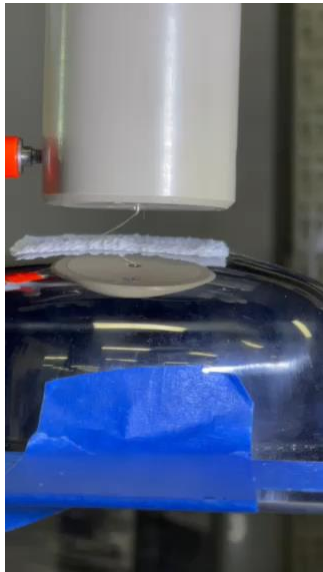
Biomanufacturing & Hybrid Processes

Integrated workflows combining hydrogels, cells, electrospinning, and 3D printing

Application scope depends on the material, structural design, post-processing, and validation strategy; the platform provides a controllable manufacturing foundation.

Solvent-Free Melt Electrowriting

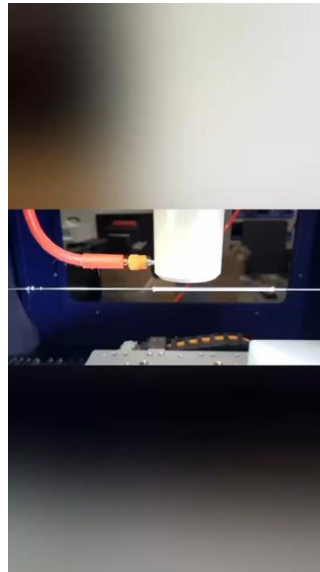
A high-voltage field draws the polymer melt while the precision stage deposits it along programmed paths.



Curved PCL Scaffold

1-100 μm

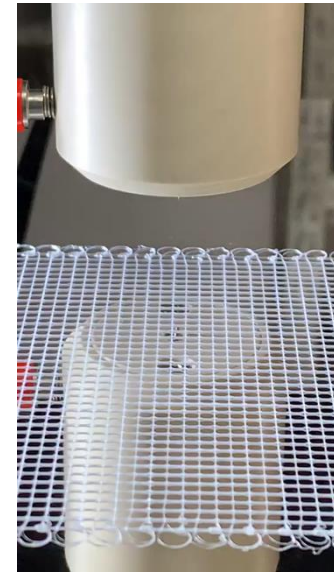
Fiber-Diameter Range



Tubular / Mandrel Structure

2D / 3D

Programmed Paths and
Layerwise Deposition

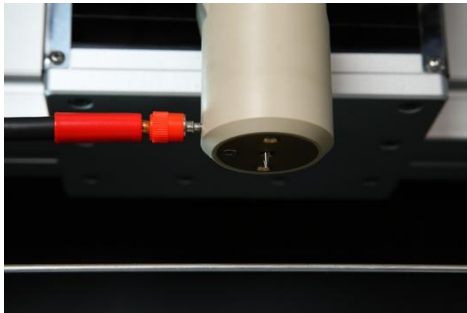


Planar Multilayer Grid

Solvent-Free

For Melt-Processable Polymer
Systems

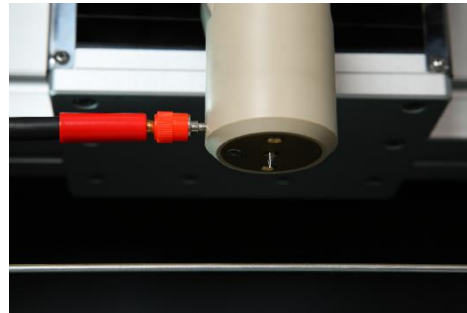
Three Melt Printheads for Distinct Temperature Ranges



Low-Temp. Printhead

Ambient–200 °C

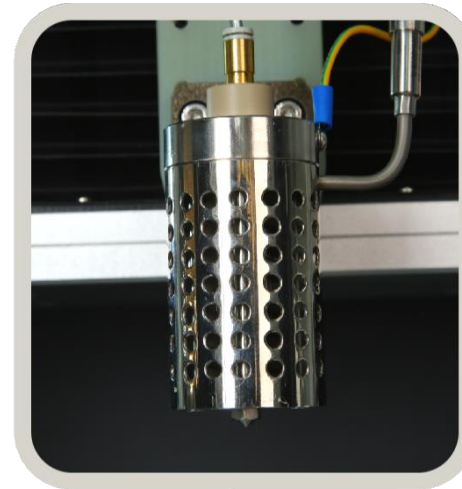
5 mL glass syringe



Low-Temp. Detail

**Direct high-voltage
connection**

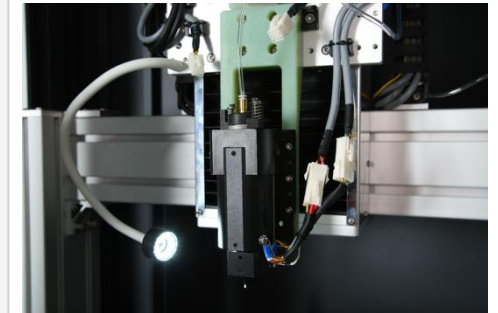
Multiple needle sizes



Mid-Temp. Printhead

Ambient–300 °C

Dual-zone barrel/tip heating

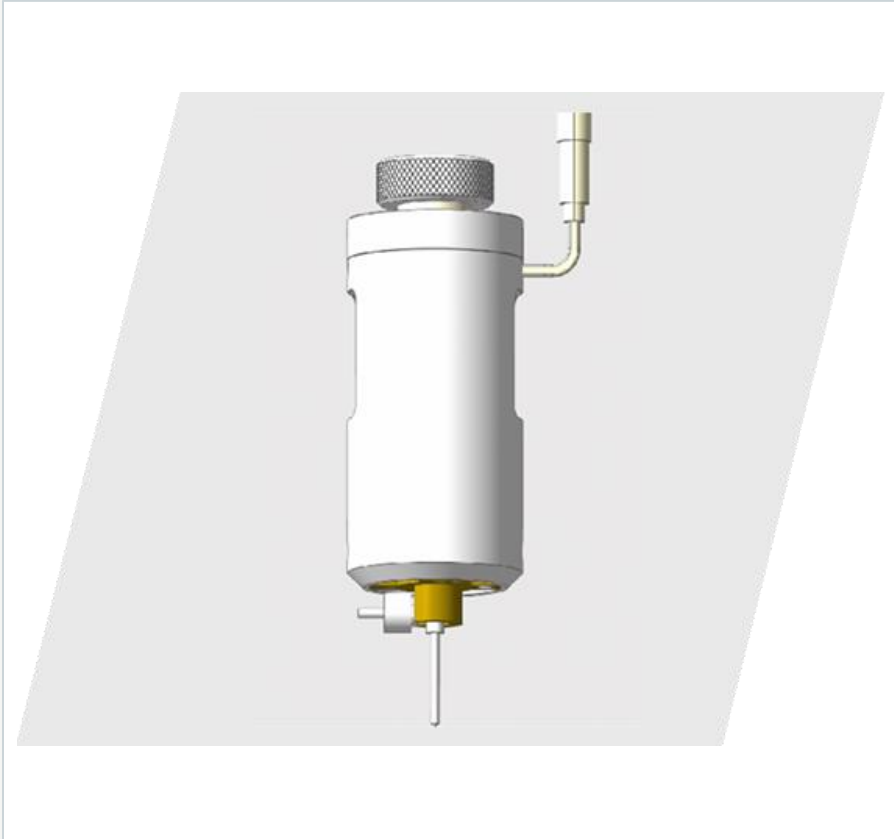


High-Temp. Printhead

Ambient–400 °C

Steel or ceramic barrel

Thermal Control and Feeding for High-Temperature Materials



Coaxial Hot-Air Shield

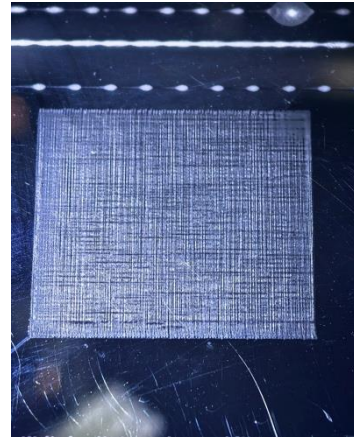
- 25–120 °C outer-zone heating
- Limits ambient effects and early solidification
- For high-temperature melt printheads

Pneumatic Feed

- Three pressure resolutions
- Air pump or inert-gas drive
- For heat-sensitive or degradation-prone materials

Inert-gas and cylinder arrangements are defined by the final configuration.

Near-Field Solution Direct Writing for Flexible Materials



**Ordered Membrane
Pattern**



**Continuous Fiber
Trajectory**



**Flexible Printed
Sample**

1-45 μm

Glass-Needle Diameter Range

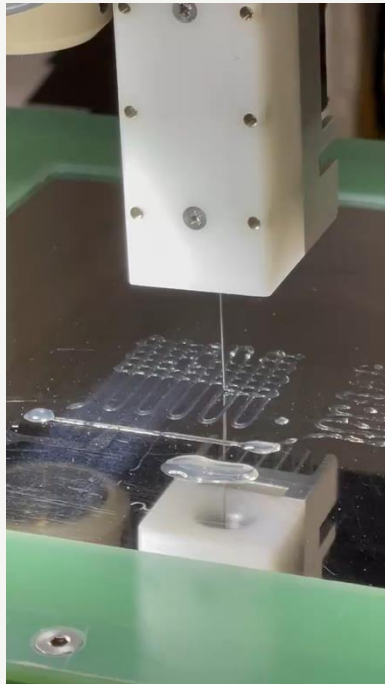
0.01-99.9 mL/h

Liquid Feed Rate

Lines / Curves

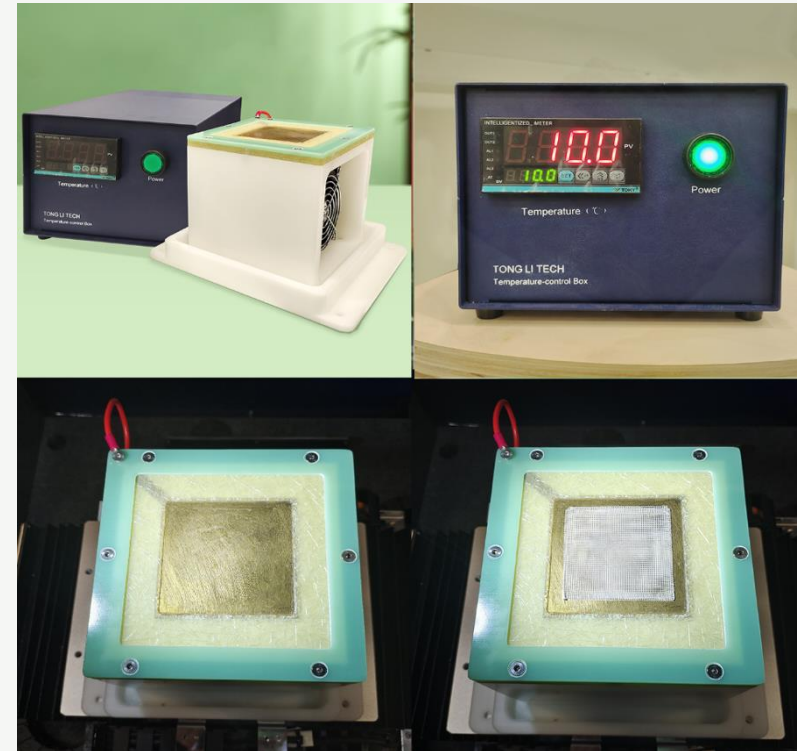
Continuous Programmable Paths

Low-Temperature Hydrogel Direct Writing



Low-Temp. Hydrogel Printhead

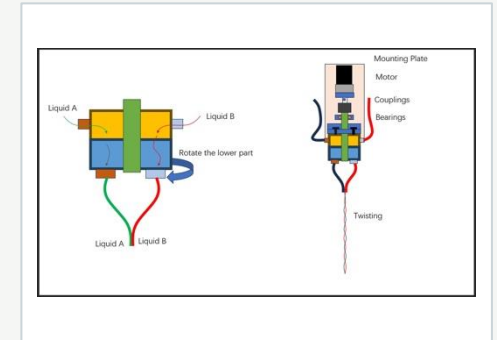
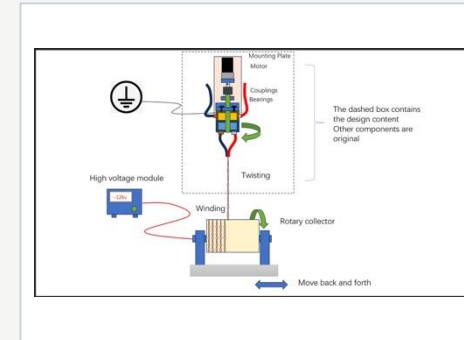
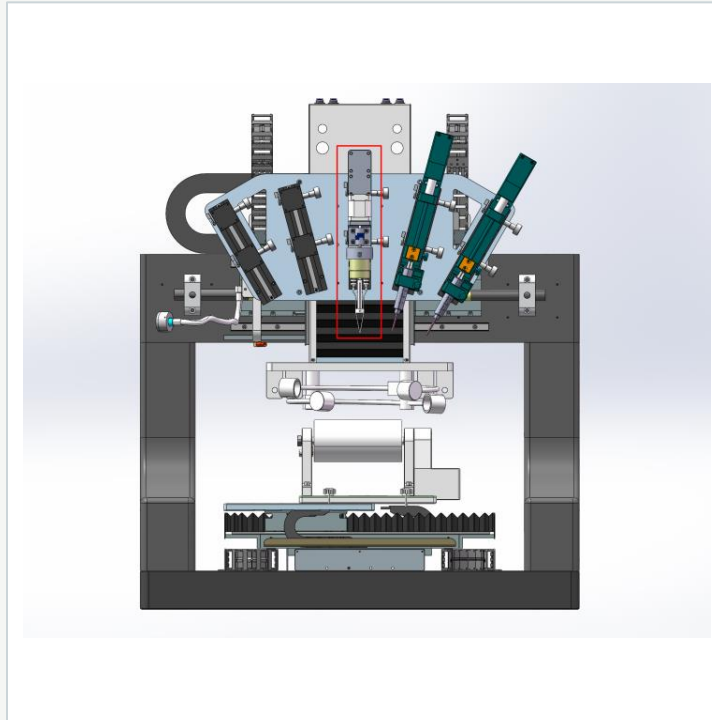
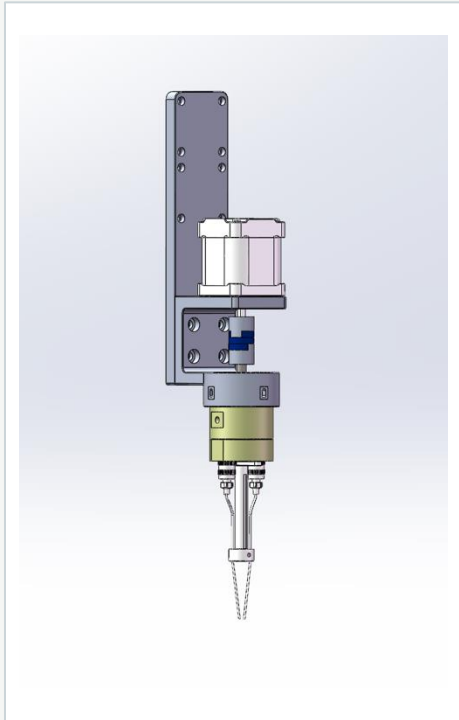
Ambient–37 °C; optional nozzles.



Down to $-4\text{ }^{\circ}\text{C}$ $100 \times 100\text{ mm}$

Rotating Side-by-Side Spinneret composite fibers

Dual-solution direct writing with in-line twisting for



Dual-Channel Extrusion

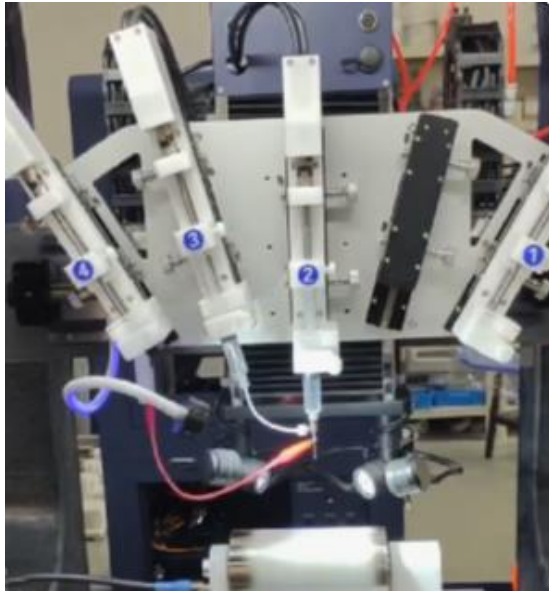
Combines two solution streams in one composite fiber.

1-100 rpm

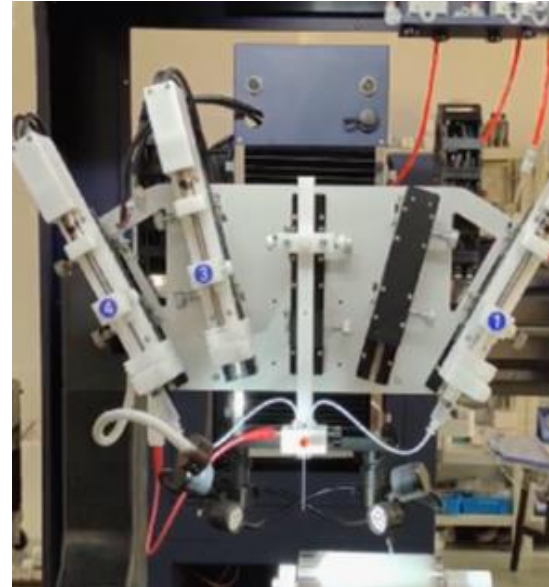
Digitally adjustable rotational-speed range.

Supports research on twisted, composite, and multicomponent fiber architectures.

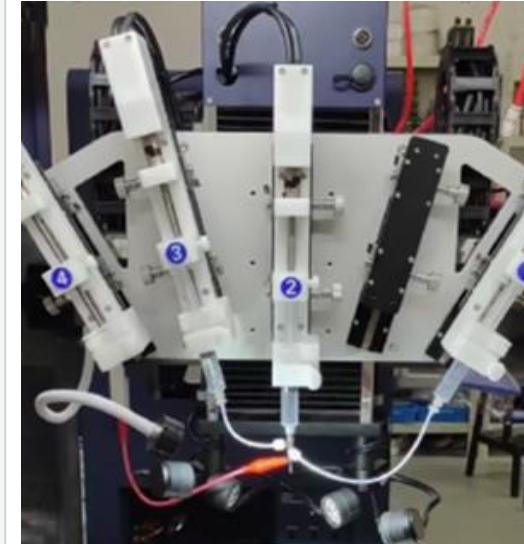
Electrospinning for Dense Nanofibrous Membranes



Single Spinneret



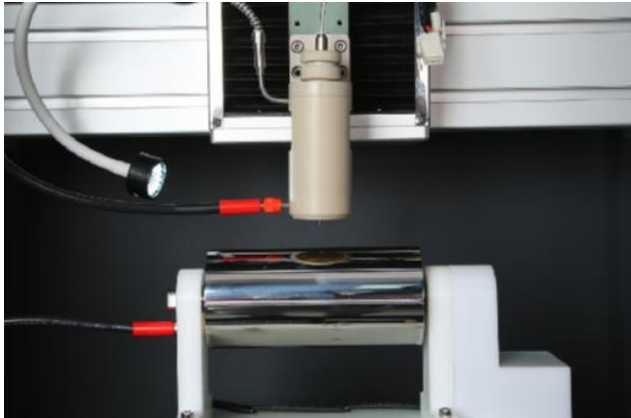
**Side-by-Side
Spinneret**



**Coaxial / Triaxial
Spinneret**

For core-shell, side-by-side, or multilayer fibers; final channel and needle sets depend on configuration.

Collector Choice Defines Sample Geometry and Research Scope



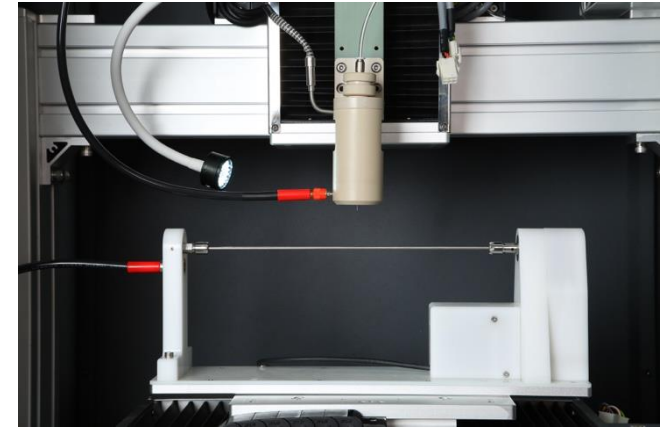
Rotating Drum

Ø76 × 150 mm



X-Y Flat-Plate

200 × 200 mm

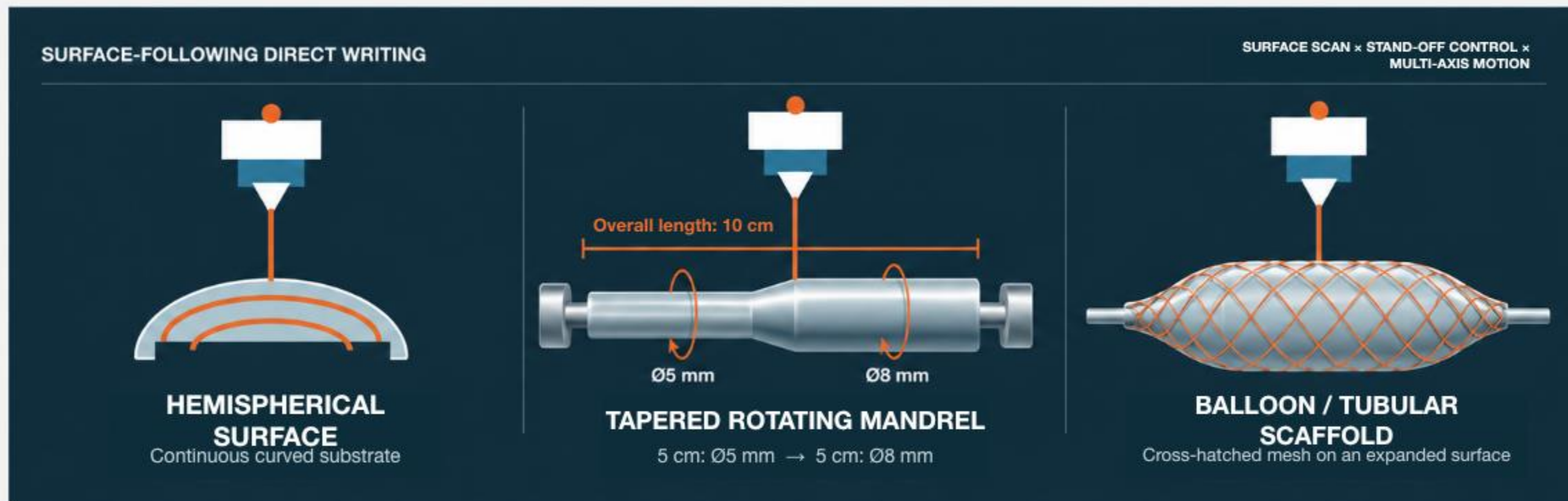


Fine-Mandrel Collection

Ø1–6 mm
Custom diameters

Precision Fiber Paths Across Complex Curved Surfaces

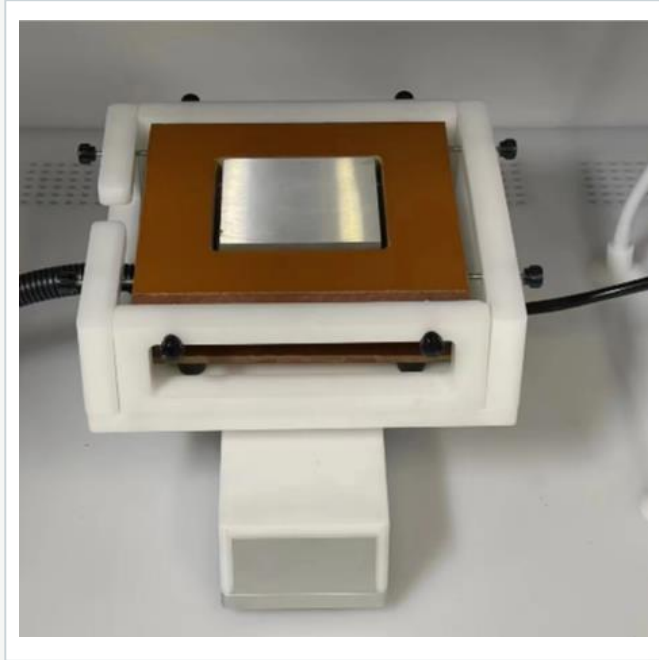
Surface scanning and constant stand-off control enable direct writing on hemispherical, tapered-shaft, and balloon geometries.



Complex Geometry—Without Sacrificing Path Order

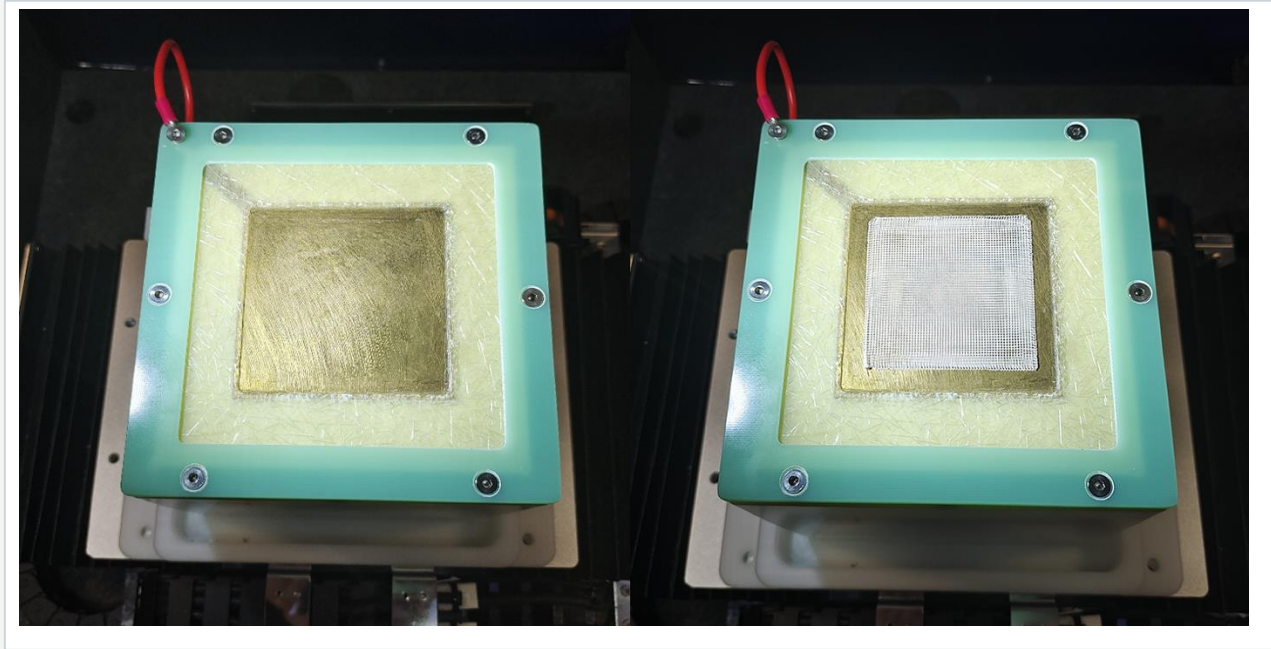
Surface scan → Stand-off lock → Path compensation → Precision writing

Temperature-Controlled Collectors



Heated Collector

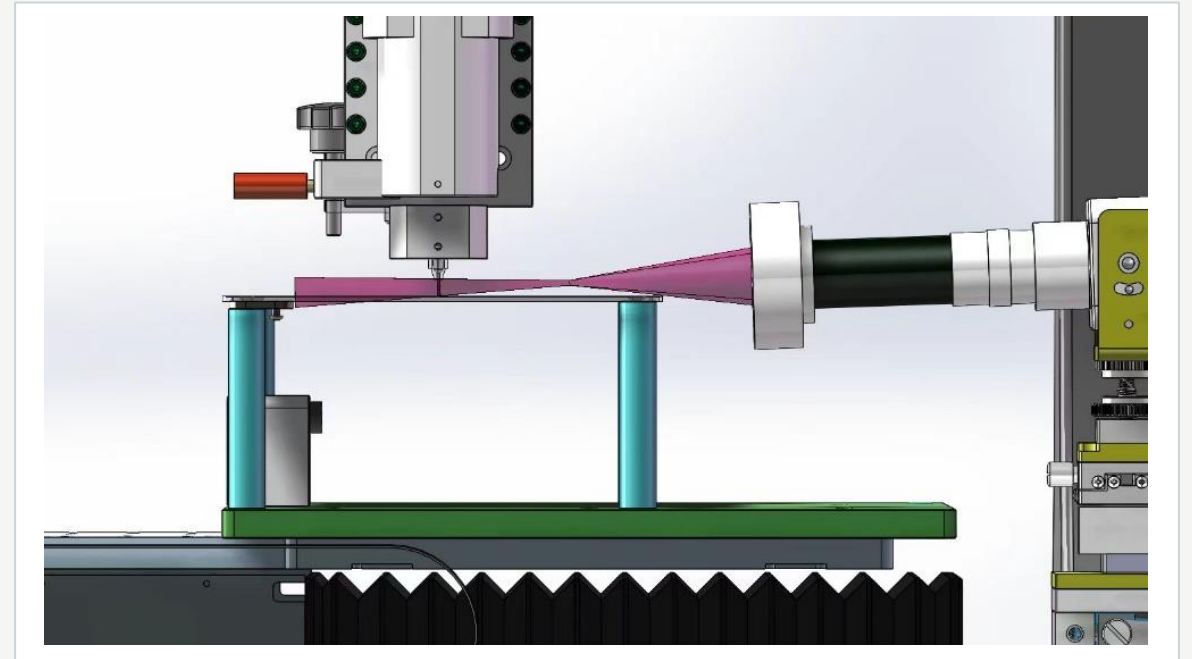
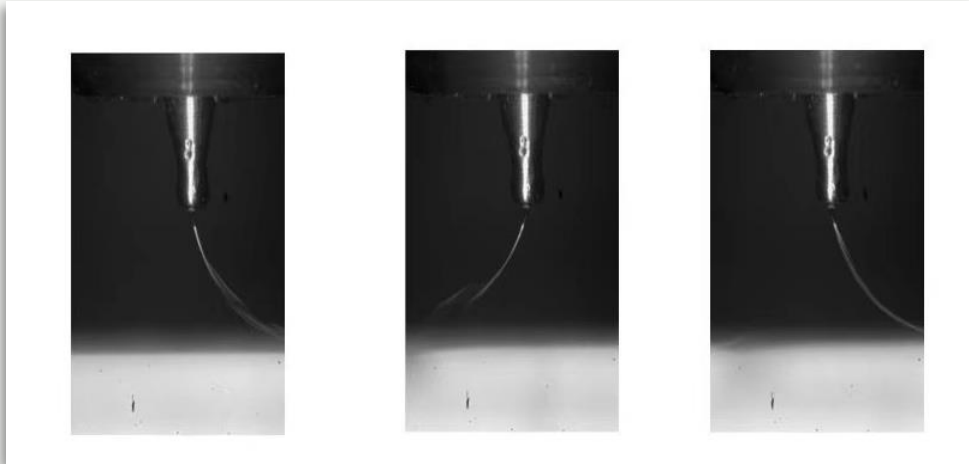
Ambient to approximately 120 °C
Effective area: 180 × 180 mm



Cooling Stage

Down to -4 °C · 100 × 100 mm
Anti-frost / anti-condensation
at 10 °C

Real-Time Jet Observation



Adjustable focus for documenting fiber drawing and jet behavior.

Pneumatic Direct Writing with In-Situ UV Curing

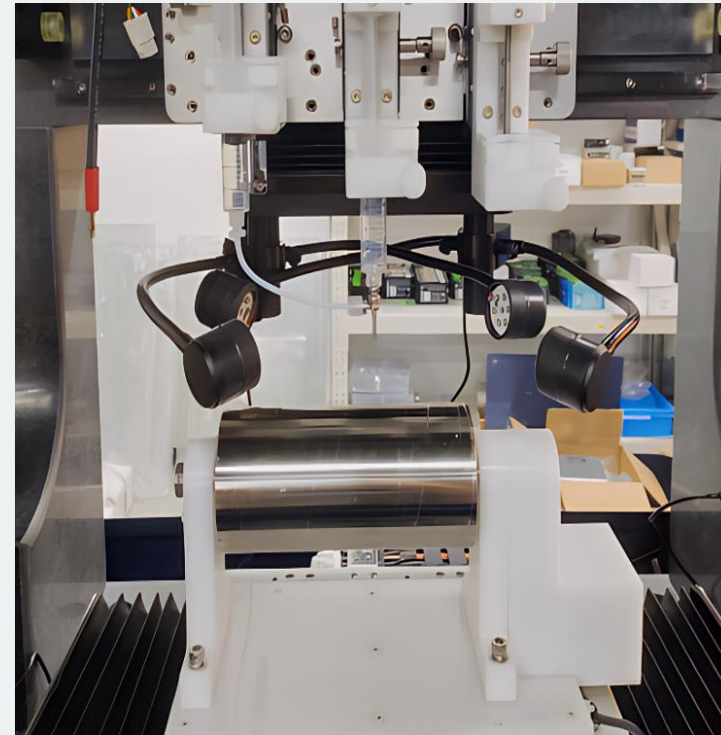
Pneumatic extrusion meters photocurable material while four UV lamps cure the deposited path in situ.

PNEUMATIC DIRECT WRITING + IN-SITU UV CURING

Pneumatic Writing + In-Situ UV Curing

No high voltage is used. Pneumatic metering deposits photocurable material along a programmed path while synchronized UV exposure cures it in situ.

- Stable Feed** Flow-adjustable pneumatic extrusion.
- Concurrent Curing** Four UV lamps improve curing throughput.
- Configurable UV** Wavelength, power, and format can be configured.



Pneumatic Feed → Metered Extrusion → Path Deposition → In-Situ UV Curing

Precision Motion for Repeatable Toolpaths

X (Upper) / Y (Lower)

>180 mm travel

Up to 200 mm/s

Positioning accuracy: $\pm 2 \mu\text{m}$

Z Axis

>80 mm travel

Up to 50 mm/s

Base & Drives

Granite base; X/Y linear motors; Z servo.



Integrated Thermal, Pressure, and Feed Control

Coordinated four-channel heating, selectable pressure resolution, and dual-channel liquid feeding.

FOUR-CHANNEL PROGRAMMABLE HEATING

Four-Channel Heating

CH 01	RT–150 °C	Four-Stage Temperature Ramping Independent dwell time for each stage enables controlled heating and helps prevent material degradation caused by rapid temperature rise.
CH 02	Collector Plate	Collector-Plate Temperature Control Controls the deposition-zone temperature to support material placement and curing.
CH 03	RT–400 °C	High-Temperature Heating Channel Heating range: ambient to 400 °C.
CH 04	RT–300 °C	Independent Heating Channel Heating range: ambient to 300 °C.

TOUCHSCREEN PRESSURE CONTROL

Three Pressure Resolutions

Touchscreen inlet-pressure setting.

0.1

0.01

0.001

MPa / three selectable settings

DUAL-CHANNEL LIQUID FEEDING

Dual-Channel Feed

0.01–99.9

mL/h

Compatible with 10 mL / 20 mL syringes

SOFTWARE Four-Channel Heating

Temperature Control — Translated Presentation View				
	CH1	CH2	CH3	CH4
Measured Temp.	0.0	0.0	279.9	294.8
Setpoint 1	60.0	128.0	180.0	120.0
Ramp Time 1	6.0	5.0	3.0	5.0
Setpoint 2	90.0	180.0	175.0	180.0
Ramp Time 2	5.0	5.0	5.0	3.0
Setpoint 3	120.0	220.0	225.0	230.0
Ramp Time 3	5.0	6.0	5.0	3.0
Setpoint 4	140.0	270.0	280.0	295.0
Ramp Time 4	12.0	10.0	10.0	5.0
Thermocouple	FAULT	FAULT	CONNECTED	CONNECTED
Heating Status	HEAT OFF	HEAT OFF	HEAT OFF	HEAT OFF
Heater Switch	HEATER OFF	HEATER OFF	HEATER ON	HEATER ON
Autotune	AUTOTUNE OFF	AUTOTUNE OFF	AUTOTUNE OFF	AUTOTUNE OFF
			LIMITS	MICRO PUMP

Dual-Interface Control Software

Process settings and multi-axis execution remain visible on separate displays.

Dual-Monitor Architecture



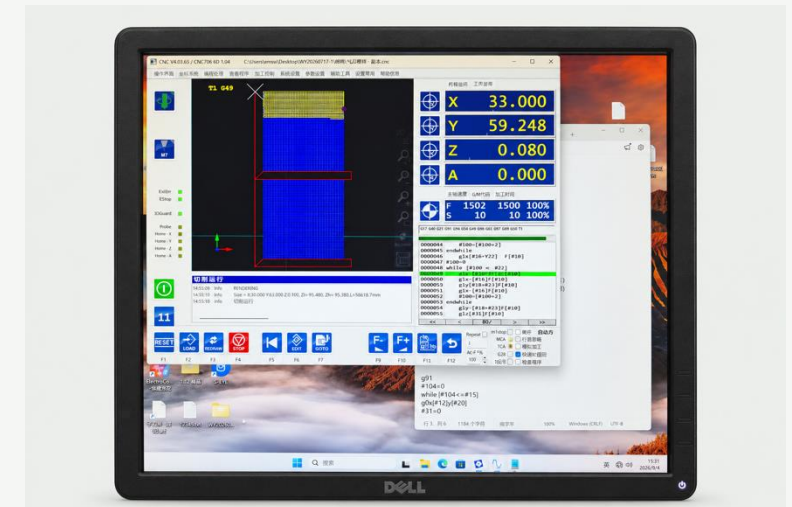
Two dedicated displays keep process settings and motion execution visible simultaneously.

Thermal & Process Control



Independent heater channels support stepped setpoints, dwell times, thermocouple status, and output switching.

Motion & G-Code Control



Toolpath preview, X/Y/Z/A position monitoring, feed status, and line-by-line G-code execution.

Graphics-to-Toolpath and Multi-Axis Control

Import CAD/STL files or convert photographs, scans, and sketches into executable print paths.

CONTROL PLATFORM

EdingCNC Control System

CNC4.03 Control Software

Import Design Files

2D	CAD File	Planar Geometry
2.5D	CAD File	Layered Toolpath
3D	STL File	3D Model

After import, paths, speeds, and print parameters remain editable.

PATH GENERATION & PLANNING

From Graphic to Printable Path

A 2D GRAPHICS EDITOR

Graphics to Toolpaths

Converts photos, scans, sketches, and digital drawings.

B PARAMETRIC GRID

Parametric Grids

Generates grid paths from key dimensions without a CAD model.

C SPEED PLANNING

Segmented Speeds

Assign speeds by geometry, region, or path segment.

G-CODE MAKER

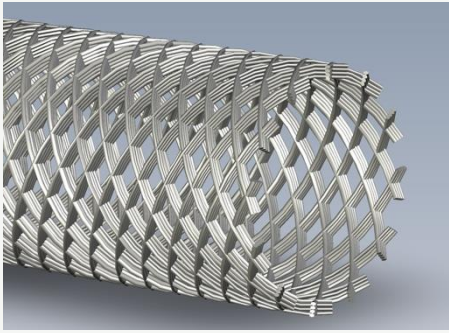
G-Code & Multi-Axis Execution

Converts geometry, speed, and process settings to executable G-code.

Create print programs for regular grids or custom geometries without complex modeling.

Template-Based G-Code and Batch Printing

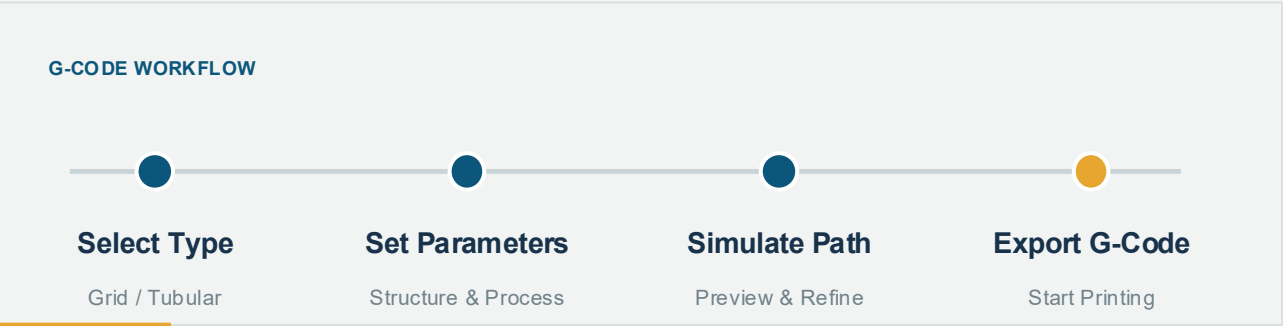
Generate G-code with fewer repetitive steps, including parameter sweeps, warm-up paths, and stacked geometries.



PARAMETRIC TEMPLATE + PATH SIMULATION

Parameter-Driven Grid and Tubular Structures

Built-in grid and tubular templates generate geometry from structural and process parameters; dry-run simulation supports toolpath review and refinement.



Simulate first, then print: preview and refine the toolpath before execution.

AUTOMATED PRINT PREPARATION

Automated Print Preparation

PARAMETER SWEEP

Parameter Sweep · Batch Printing

Run multiple parameter sets and geometries for process screening or batch production.

WARM-UP ZONE

Print Warm-Up Zone

Warm up first; start the target path automatically when flow stabilizes.

STACKED GEOMETRY

Stacked-Geometry Printing

Stack geometries in sequence with a separate warm-up before each transition.

Integrated Safety Architecture



Emergency Stop

Rapid operator access



Power Protection

Shutdown on overvoltage or overcurrent



Door Interlock

Disables high voltage when the enclosure door opens

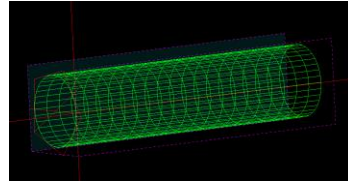


Grounding

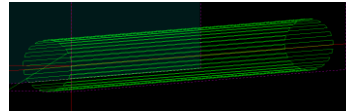
Enclosure, supply, pumps, and collectors

The safety architecture does not replace laboratory risk assessment, material-compatibility review, or compliant operating procedures.

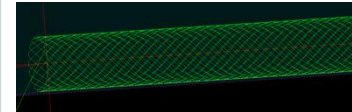
Tubular Scaffold Workflow



Parametric Model



Axial Path



Cross-Hatched Path



Printed Structure

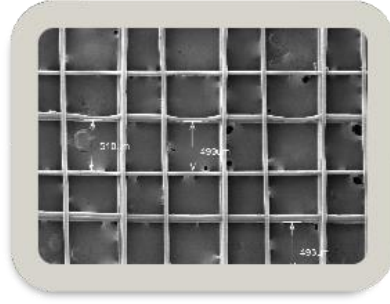
Parametric paths reduce manual line-by-line drafting.

Rotation, fiber angle, spacing, and layers define porosity, compliance, and mechanical response.

Programmed Toolpaths, Diverse Sample Geometries



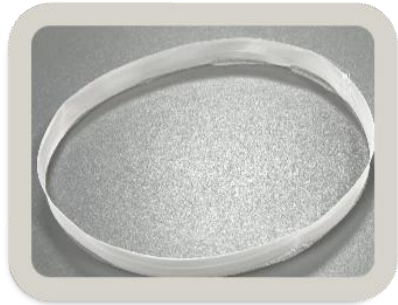
Fiber Bundle



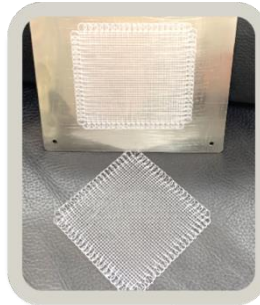
Regular Grid



Flexible Laminate



Annular Sample



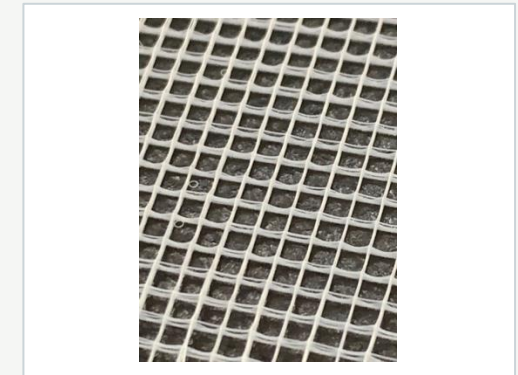
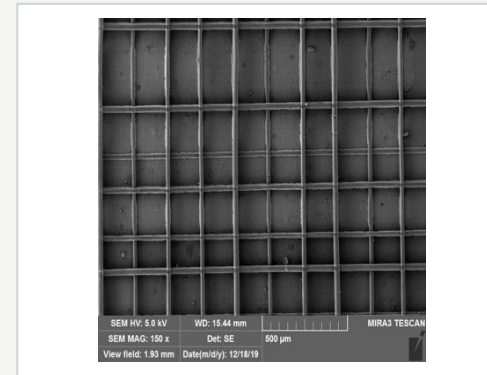
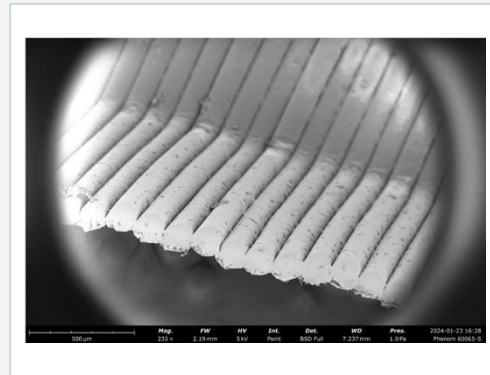
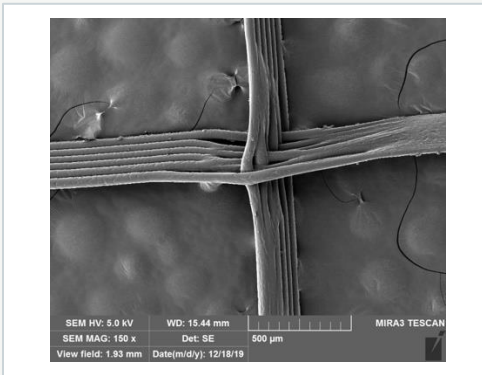
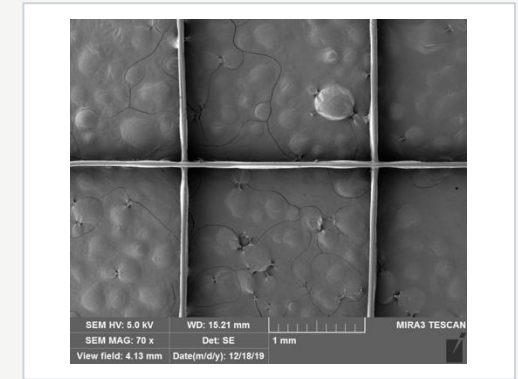
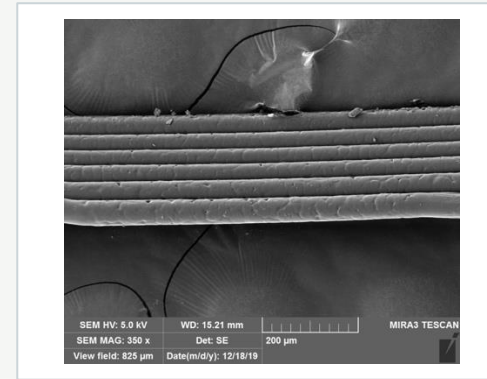
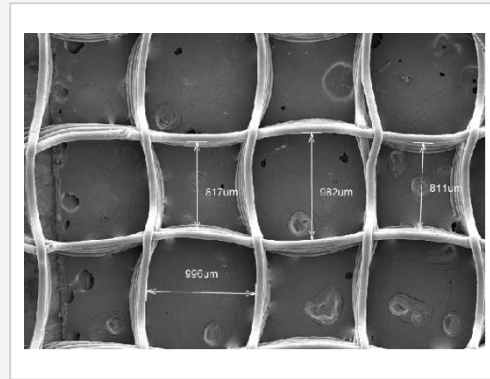
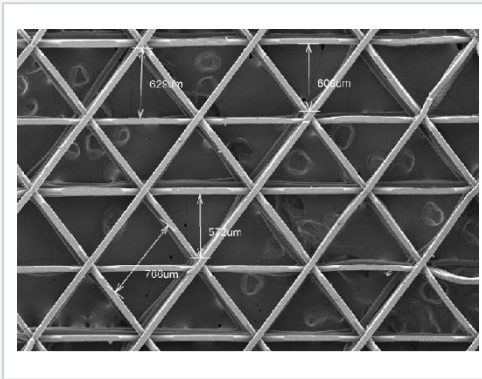
Multilayer Scaffold



Planar Membrane

Sample morphology and performance depend on the material, printhead, process parameters, environment, and post-processing.

Fiber Stacking and Crossover Microstructures



Crossover nodes, fiber fusion, and interlayer offset provide feedback for refining the process window.

Key Technical Parameters at a Glance

Processes	Melt electrowriting / Near-field solution direct writing / High-voltage electrospinning
Melt Temperature	Ambient to approximately 200 °C / 300 °C / 400 °C, depending on printhead
Near-Field Feed	0.01–99.9 mL/h; glass-needle diameter: 1–45 µm
Motion Stage	X/Y travel >180 mm; up to 200 mm/s; positioning accuracy ±2 µm
Z Axis	Travel >80 mm; up to 50 mm/s
Rotary Collection	Drum Ø76 × 150 mm; mandrels Ø1–6 mm; 0–600 rpm
Thermal Collection	Heating to approximately 120 °C; cooling stage to approximately –4 °C (optional)
Software	CAD / STL / image-to-path conversion; parametric grids; programmable speed

**Final specifications
follow the confirmed
configuration**

Available process windows
vary with the material,
printhead, collector, and
optional modules.

Confirm the material and target
structure before purchase.

Configuration Starts with the Research Question

Core Research Platform

- Three electrohydrodynamic writing modes
- Precision motion platform
- Standard printhead and flat-plate collector
- Software and safety architecture

Material-Specific Options

- Melt printheads: low / mid / high temperature
- Inert-gas material feed
- Low-temperature hydrogel printhead
- UV-curing module

Geometry-Specific Options

- Rotary / heated / cooled collection
- Curved-surface scanning and following
- Coaxial / side-by-side / triaxial spinnerets
- Rotating twisting spinneret

Configuration Review: Material Thermal History → Target Fiber Scale → Sample Geometry → Collection Method → Environment & Post-Processing → Validation Method

TL-TRINITY

Precision Micro/Nanofiber Direct-
Writing Platform

Turn Research Concepts into Testable Microstructures

From material windows and process parameters to fiber trajectories,
make every experiment clearly observable and verifiable.

Research Planning · Material Windows · System Configuration

Start a Technical Discussion

Email: tonglitech@outlook.com WhatsApp: +852-65920586 WeChat: 18620353785 Tel: +86-18620351601



TRINITY

PRECISION FIBER
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