Supporting Information

Title
Valve-based consecutive bioprinting method for multimaterial tissue-like constructs with controllable interfaces

*Heran Wang, Kai Guo, Liming Zhang, Huixuan Zhu, Shijie Li, Song Li, Feiyang Gao, Xin Liu, Qi Gu, Lianqing Liu, Xiongfei Zheng**

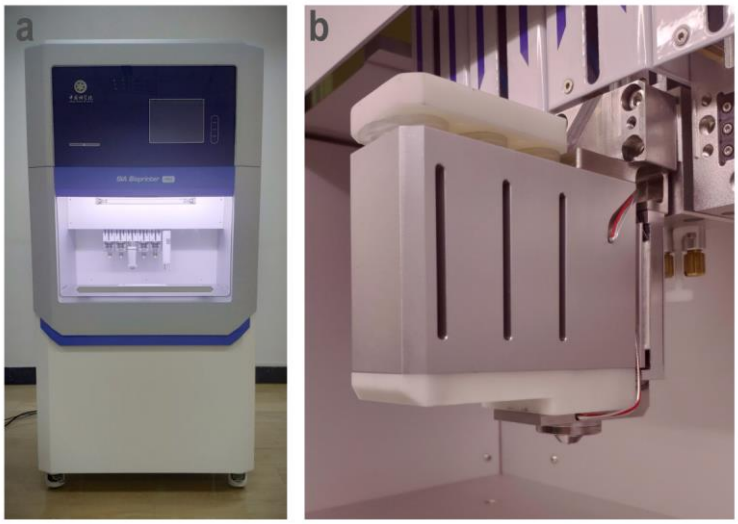

Figure S1. Photos of the experimental platform. (a) Bioprinter (SIA bioprinter PRO) designed and manufactured by our research team. The bioprinter includes precision motion control function (triaxial positioning accuracy ± 5 μm), temperature control function and various functional interfaces adapted to various types of printheads (up to 5 printheads) (up to 5 printheads). (b) Consecutive printhead specially designed based on the interlaced valve. The printhead consists of two temperature controls and three storage cylinders.

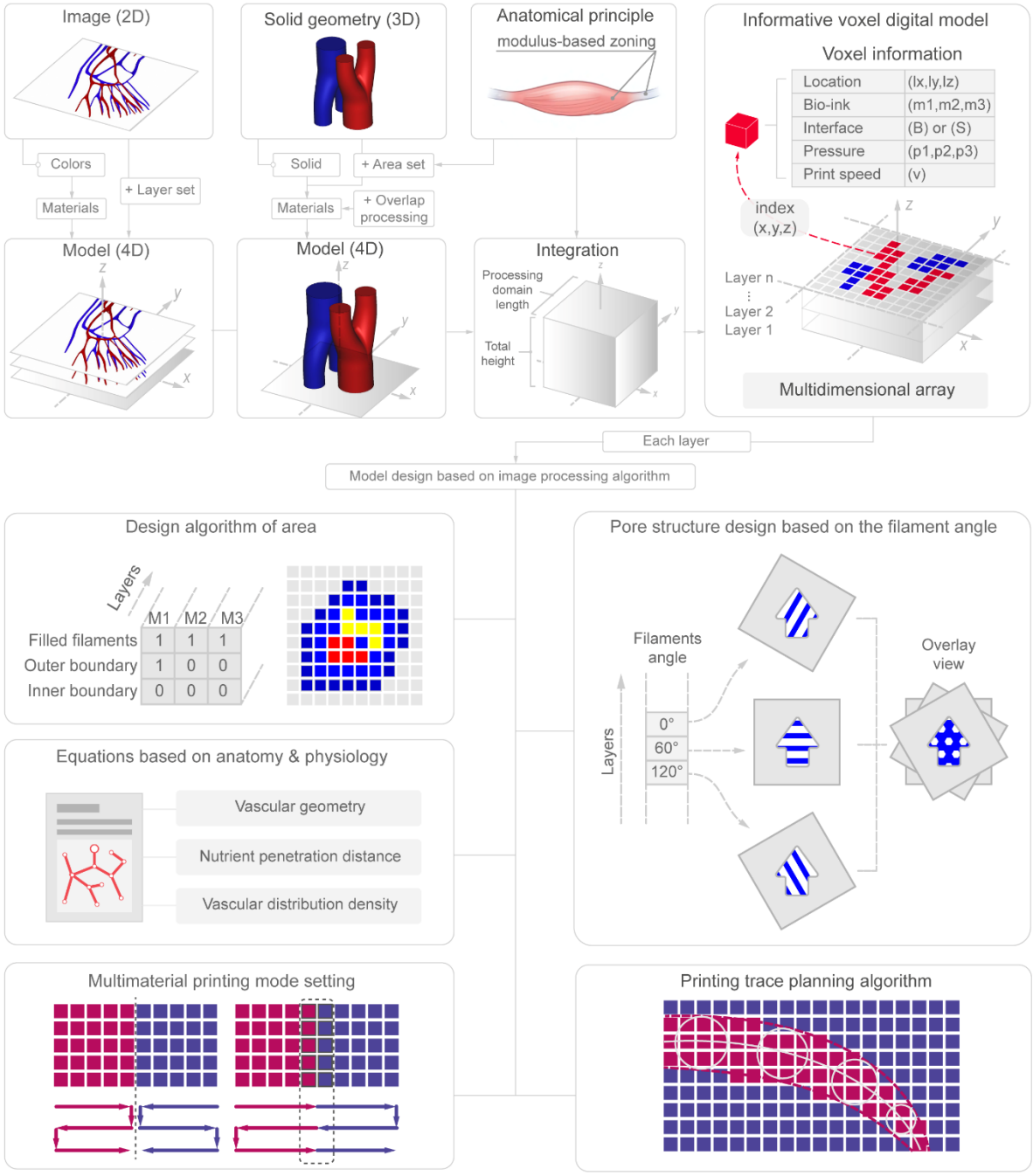

Figure S2. Software algorithm roadmap applied to the valve-based consecutive bioprinting (VCB) method. The original data sources can be 2D images, solid geometry, or even quantitative physiological principles. They will be integrated into an informative voxel digital model, stored in a multidimensional array. The data of each layer can be regarded as a digital picture, which can be applied to image processing algorithm to realize the structural design and control planning, including (1) design algorithm of area, (2) coordinated equations of anatomy, (3) structure design of pore, (4) multimaterial printing mode setting, and (5) planning algorithm of traces.

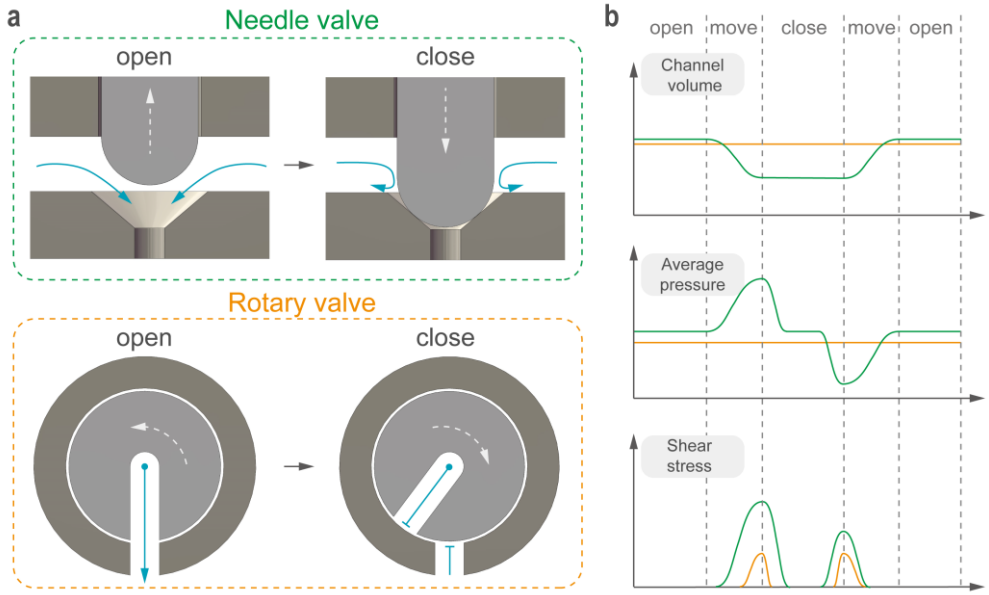

Figure S3. Contrastive analysis between needle valves and rotary valves for channel volume, average pressure, and shear stress. (a) Structural mechanism diagrams of two types of valves. Blue arrows represent the flow directions. (b) The contract analyzed for the mechanical environment of the cells in bioink. The channel volume keeps stable during the motion for the rotary valve, resulting in little pressure and stress oscillation.

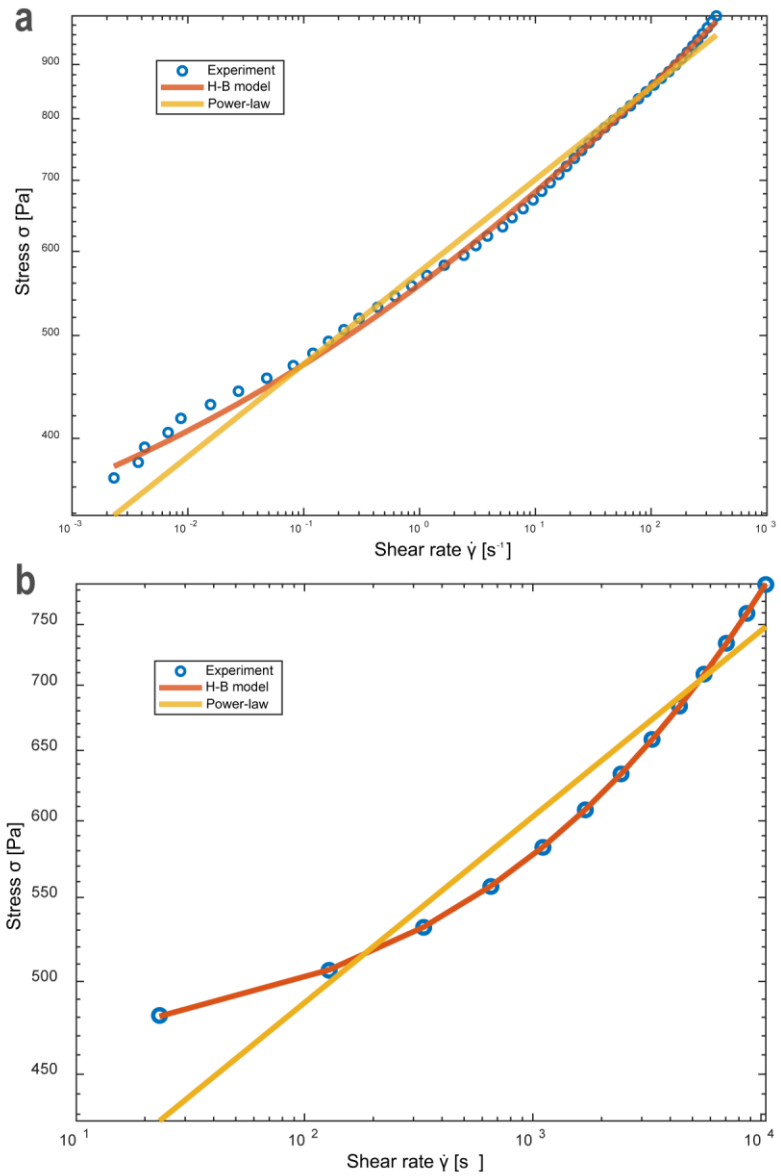

Figure S4. Rheological flow curves of Pluronic F127 and parameter discrimination curves of the H-B and power-law models. It can be seen from the figure that the H-B model fits better in all frequency regions.

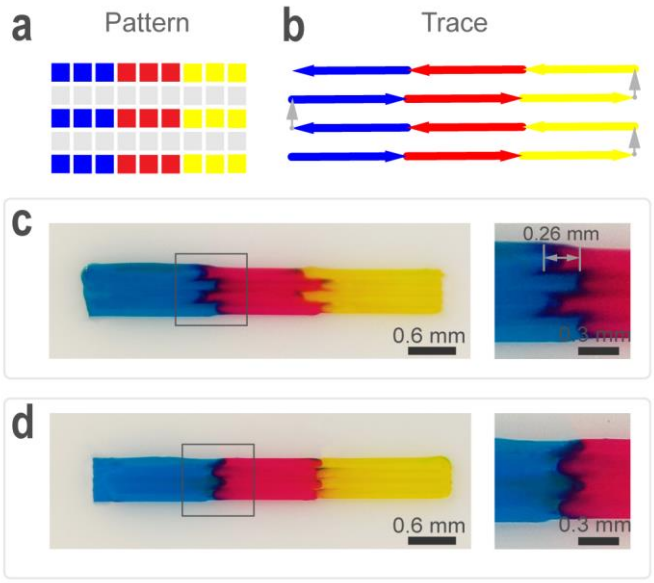

Figure S5. Switching delay distance control by adjusting the amount of advance. (a) Pattern in the volelated digital model. (b) Trajectories generated from the voxel model. (c) Print effect without the compensation. (d) Print effect with the compensation.

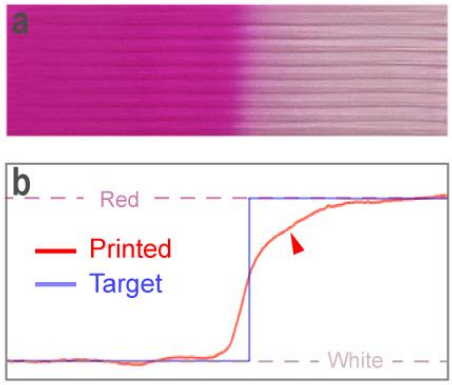

Figure S6. Image analysis of the switching speed by designed software. (a) Image of printed structs. (b) Image analysis indicating the material swiching.

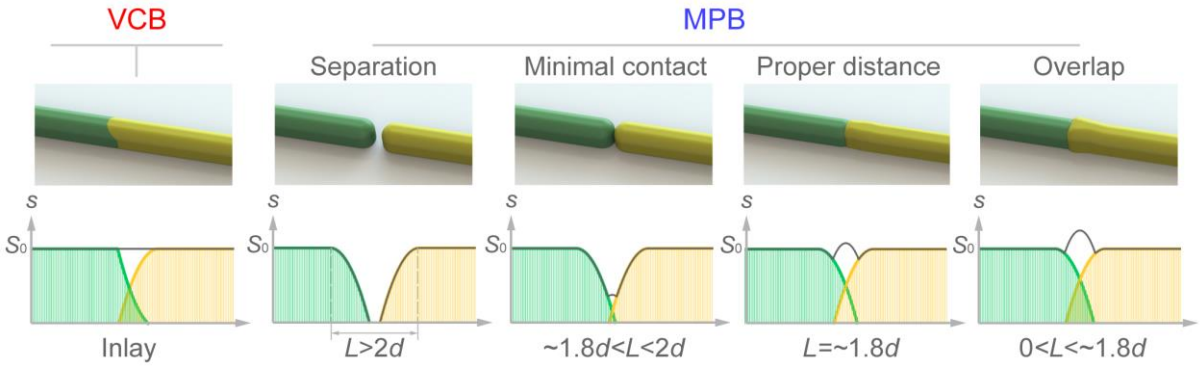

Figure S7. Simulated analysis of the interface control by two methods indicating that the interface quality in the MPB method is greatly influenced by the distance between the endpoints of the filament.

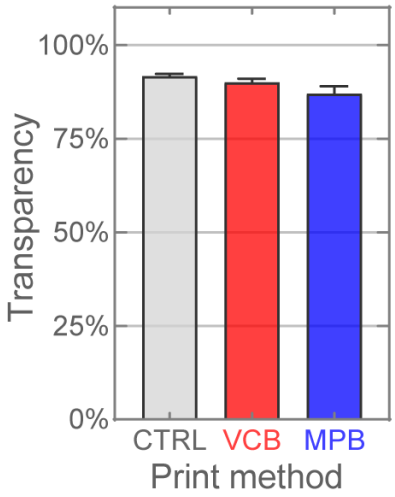

Figure S8. Transparency test of 2 mm thick printed sheetbody to characterize the defects. (mean: VCB 90.0%, MPB 85.3%) Gray control group represents the value of the carrier plate (1 mm thickness, polystyrene, customized).

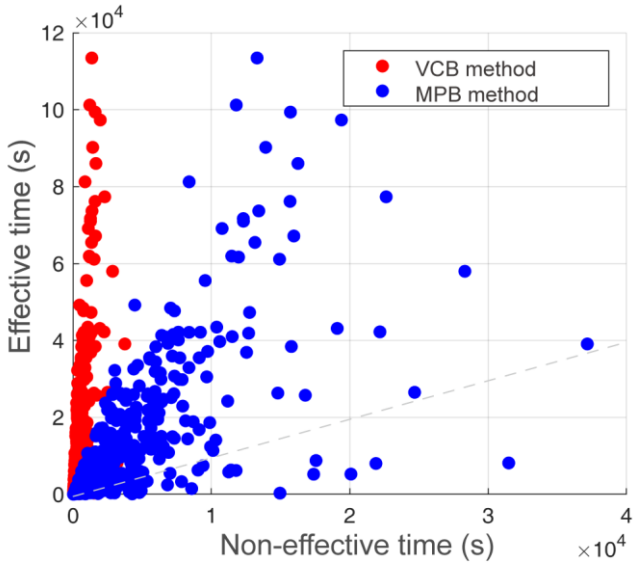

Figure S9. Five hundred simuliation results of the effective time and the non-effective time of VCB (red dots) and MPB (blue dots). The preparation of test samples follows the principle of diversity. (bodies:1~4; materials:1~3; area type:1~5) Effective time is defined as the time for direct printing behavior, which is equivalent to each trail.

File name: Movie S1.mov
Description: Movie S1 shows the consecutive switching test result of the VCB method with the confluent nozzle.
File name: Movie S2.mov
Description: Movie S2 shows the extension test of the consecutive printed structure containing two materials with different mechanical properties and a robust material interface.
File name: Movie S3.mov
Description: Movie S3 shows the light-sheet microscope 3D structure video in which the red fluorescent particles represent the blood vessels.
File name: Movie S4.mov
Description: Movie S4 shows the printing process of the muscle tissue containing blood vessels by the VCB method.
File name: Movie S5.mov
Description: Movie S5 shows the perfusion of the printed tissue structure.