Network Modulation Enables 3D-Printed Citrate-Based Polymer Scaffolds with Broadly Tunable Mechanical Performance for Regenerative Engineering

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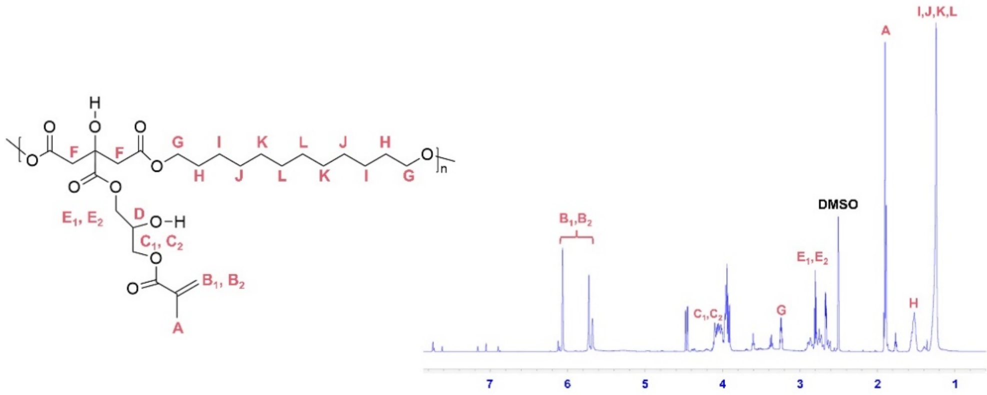
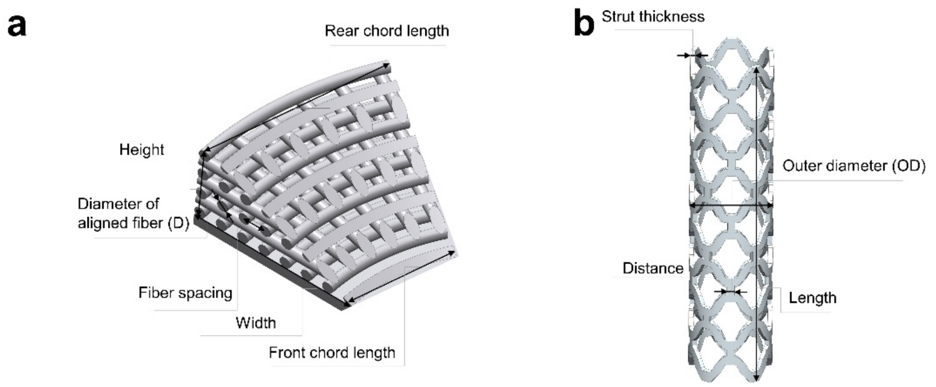


Figure S1. Chemical structure and NMR characterization of synthesized mPDC.



	mPDC	+20%IBOA	+20%IDA	+20%IBOA+5%DOD	Designed meniscus model
Height (mm)	1.28	1.34	1.39	1.32	1.40
D (μm)	201	217	181	225	200
Fiber spacing (μm)	395	398	396	394	400
Width (mm)	2.79	2.87	2.85	3.01	2.96
Front chord length (mm)	1.91	2.09	2.01	1.94	1.92
Rear chord length (mm)	3.37	3.63	3.56	3.38	3.45

	mPDC	+40% IBOA	+20% IDA	Designed stent model
OD (mm)	2.06	1.97	2.02	2.45
Strut thickness (μm)	118	94	100	136
Distance (mm)	0.182	0.163	0.167	0.230
Length (mm)	9.75	8.97	9.27	10.0

Figure S2. CAD models and comparison between designed and actual dimensions of (**a**) meniscus scaffold and (**b**) vascular stent.

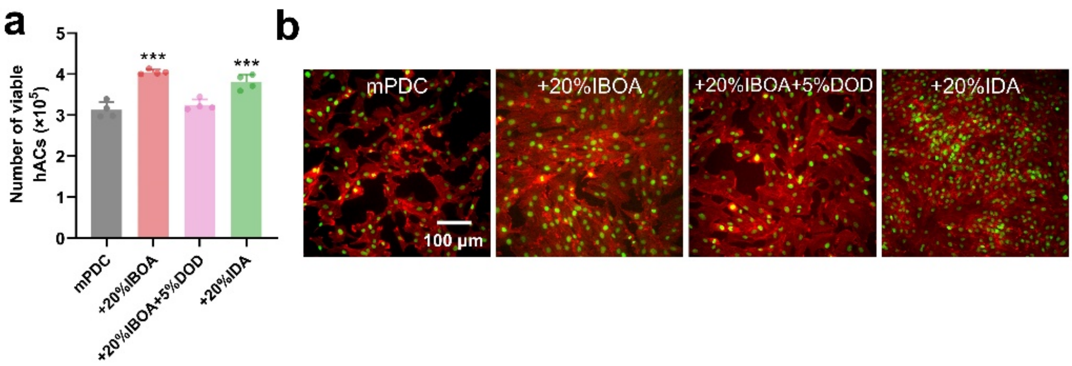


Figure S3. Cytocompatibility evaluation of hACs cultured on photopolymerized mPDC composites. (**a**) Number of viable cells (n=4) and (**b**) representative morphologies of hACs directly seeded and grown on mPDC composite surfaces, visualized by F-actin/Nuclei staining.

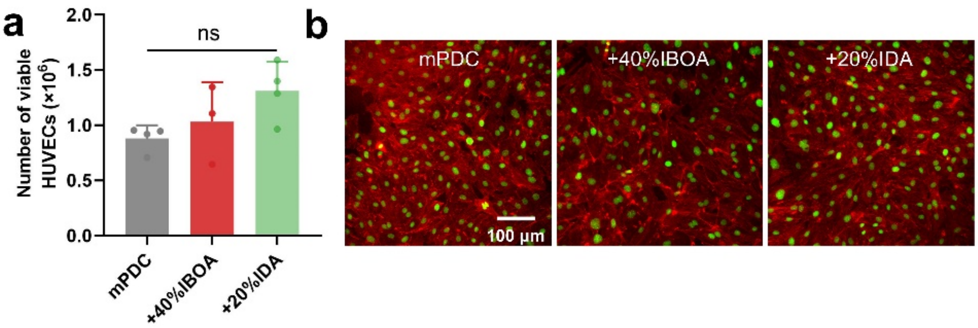


Figure S4. Cytocompatibility evaluation of HUVECs cultured on the photopolymerized mPDC composites. ((**a**) Number of viable cells (n=4) and (**b**) representative morphologies of HUVECs directly seeded and grown on mPDC composite surfaces, visualized by F-actin/Nuclei staining.

Table S1. Formulations of photopolymerizable mPDC composite inks for 3D printing.

mPDC composite Inks	mPDC (wt%)	RDs (wt%)	DOD (wt%)	Irgacure® 819 (wt%)	Absolute ethanol (wt%)
mPDC	50	0	0	2.2	47.8
+20% IBOA	50	20	0	2.2	27.8
+40% IBOA[a]	50	40	0	2.2	7.8
+20% IDA	50	20	0	2.2	27.8
+32% IDA[a]	50	32	0	2.2	15.8
+12.5% BTA	50	12.5	0	2.2	35.3
+25% BTA	50	25	0	2.2	22.8

+2.5%DOD	50	0	2.5	2.2	45.3
+5%DOD	50	0	5	2.2	42.8
+20% IBOA+5%DOD	50	20	5	2.2	22.8
pristine IBOA	0	97.8	0	2.2	0
pristine IDA	0	97.8	0	2.2	0
pristine BTA	0	97.8	0	2.2	0

a: 40 wt% IBOA and 32 wt% IDA represent the practical upper limits to ensure a homogeneous and stable ink mixture.

Table S2. Thermal properties of the photopolymerized mPDC, homopolymerized RD, mPDC+RD composites and mPDC+DOD composites.

Thermal property	mPDC	poly(IBOA)	poly(IDA)	poly(BTA)	mPDC+20% IBOA	mPDC+20% IDA	mPDC+12.5% BTA	mPDC+2.5%DOD	mPDC+5%DOD
T_d (°C)	259.1	266.1	350.6	346.0	265.7	273.9	260.9	256.3	256.9
T_g (°C)	-3.4	31.5	-57.7	-48.8	20.9	-18.9	-5.6	-4.6	-9.4

Table S3. Young's modulus, strain at break, and ultimate tensile strengths via tensile tests of photopolymerized mPDC composites.

mPDC composites	Young's modulus (%)	Strain at break (%)	Ultimate tensile strength (%)
mPDC	14.0±2.5	14.2±3.6	1.8±0.3
+20% IBOA	50.1±7.9	39.4±9.9	6.8±1.4
+40% IBOA	133.5±24.5	27.0±3.0	18.3±1.7
+20% IDA	49.0±3.4	35.3±6.5	7.1±1.5
+32% IDA	42.8±5.8	30.5±4.9	6.5±1.0
+12.5% BTA	18.9±2.1	39.0±7.1	4.5±0.6
+25% BTA	28.6±2.4	42.4±8.5	6.5±1.0
+2.5%DOD	11.9±1.7	42.5±3.2	3.8±0.6
+5%DOD	6.9±0.8	43.5±4.2	2.8±0.3
+20% IBOA+5%DOD	10.6±1.4	60.6±10.1	4.0±1.1

Table S4. 3D-printing parameters for photopolymerizable mPDC composite inks.

mPDC composite inks	Power intensity	Exposure time (s)	Layer thickness (μm)	CAD model

mPDC	1.4	0.62	5	meniscus
+20% IBOA	0.5	0.62	5	meniscus
+20% IDA	1.4	0.62	5	meniscus
+20% IBOA+5%DOD	0.5	0.62	5	meniscus
mPDC	0.6	0.33	5	stent
+40% IBOA	0.313	0.28	5	stent
+20% IDA	0.5	0.3	5	stent