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Boronate ester-crosslinked GelMA composite bioink for 3D bioprinting of cell-laden corneal stroma and *in vivo* evaluation in rabbits

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Running title: Boronate-ester bioink for corneal bioprinting

Supplementary File

Table S1. DoF of GelMA determined by the TNBS assay.

No.	DoF (%)
1	52.29
2	53.34
3	54.21
Average	53.28

Table S2. Swelling ratios of lyophilized 10% GelMA, 10% GelMA with 10% PBA@G, and 10% GelMA with 10% PBA@G and 1% PVA

Sample	10% GelMA (%)	10% GelMA with 10% PBA@G (%)	10% GelMA with 10% PBA@G and 1% PVA (%)
1	1227.39	731.07	493.69
2	1061.43	706.17	652.04
3	1114.81	698.59	683.11
Average	1134.54±84.72	711.94±16.99	609.61±101.59

Table S3. Primer sequences used for quantitative real-time PCR.

Gene	Forward primer (5'-3')	Reverse primer (5'-3')
ACTA2	CTATGCCTCTGGACGCACAACT	CAGATCCAGACGCATGATGGCA
ALDH3A1	CTCGTCATTGGCACCTGGAACT	CTCGCCATGTTCTCACTCAGCT
ACTB	CACCATTGGCAATGAGCGGTTC	AGGTCTTTGCGGATGTCCACGT

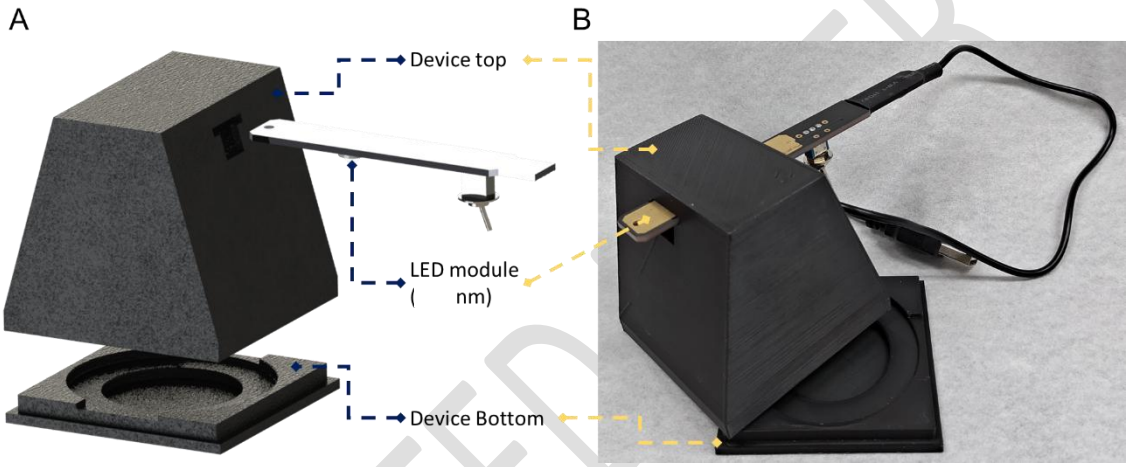

Fig. S1. Design (A) and photograph (B) of the proposed 3D-printed UV-LED device.

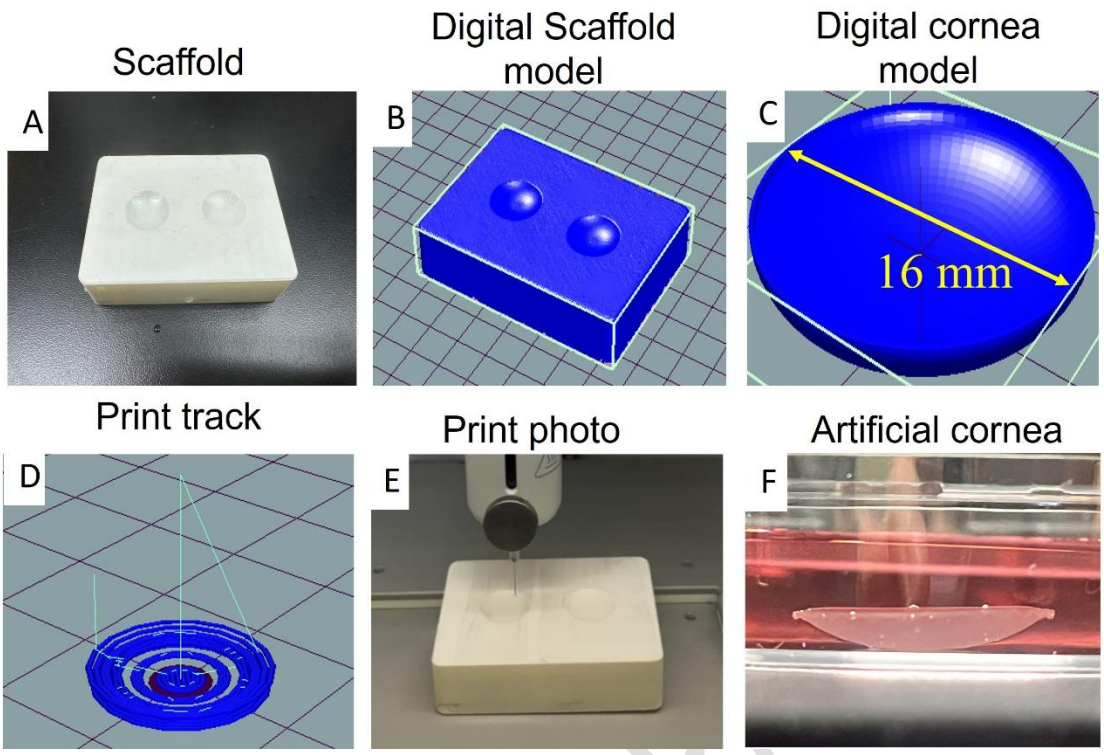

Fig. S2. The artificial cornea was printed with a BioX 3D printer. (A) Corneal mold used as the basis for digital reconstruction. (B) Digitized image generated from the scanned corneal mold. (C) Reverse-engineered digital model of the artificial cornea generated using 3D modeling software; the 16-mm model dimension is distinct from the 8.5-mm surgical trephination diameter used in the rabbit ALK procedure. (D) G-code simulation of the printing path, starting from the center and proceeding outward in concentric circles. (E) During printing, 365-nm UV irradiation was applied for 10 s after each full circle. (F) Transparent, concave-shaped artificial corneal construct printed as a single layer using a 25 G blunt needle with a 0.41-mm nozzle diameter and a programmed layer height of 0.205 mm; the completed construct was photocrosslinked at 365 nm for 120 s.

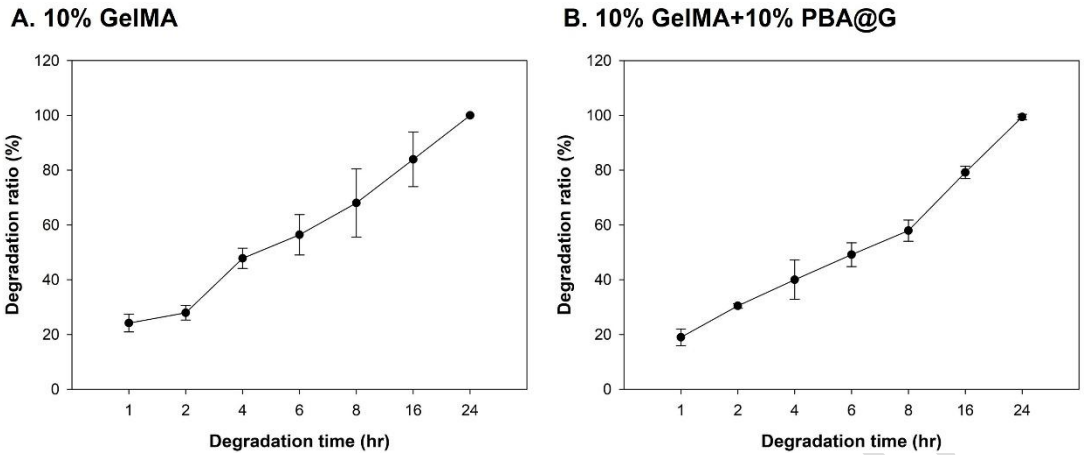

Fig. S3. Degradation rates of (A) 10% GelMA and (B) 10G10P.

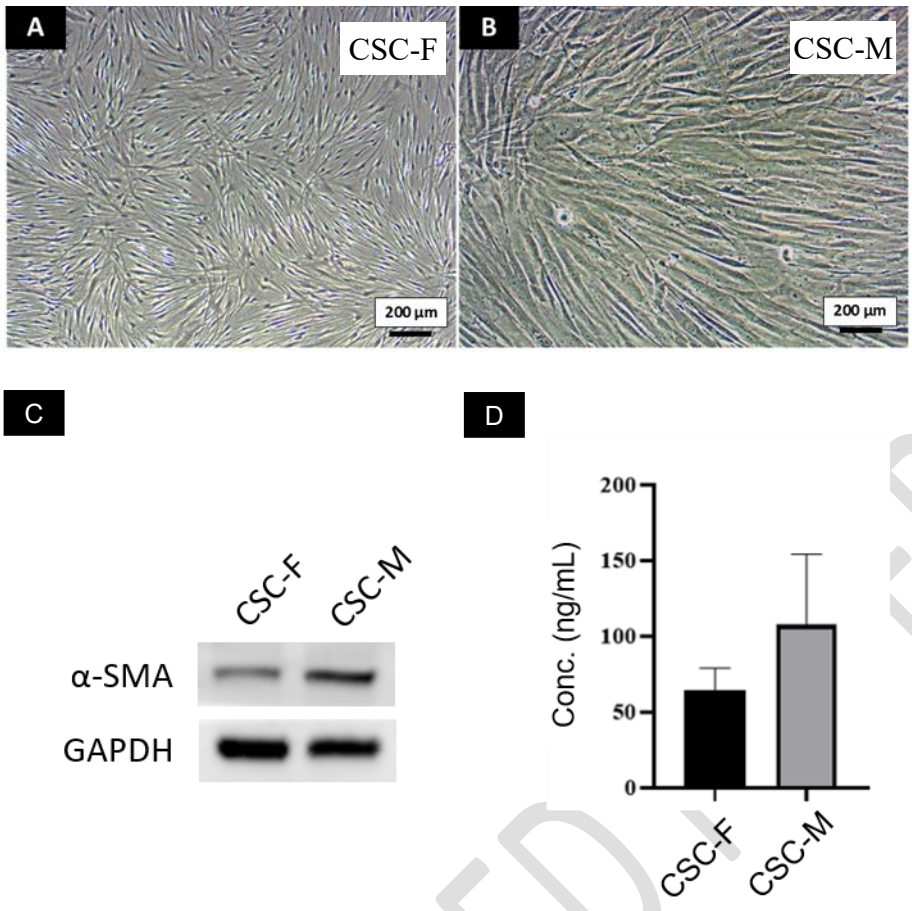

Fig. S4. Characterization of CSC reference states. Representative morphology of (A) CSC-F cultured under conditions intended to limit myofibroblastic activation and (B) myofibroblast-like CSC-M. (C) α-SMA protein expression in CSC-F and CSC-M. (D) MMP-2 levels in culture media from CSC-F and CSC-M. These in vitro reference states were used for phenotype-associated comparison and were not measurements of molecular expression in rabbit corneal tissue after implantation.