

Supplementary Materials for **Bioinspired living structural color hydrogels**

Fanfan Fu, Luoran Shang, Zhuoyue Chen, Yunru Yu, Yuanjin Zhao*

*Corresponding author. Email: yjzhao@seu.edu.cn

Published 28 March 2018, *Sci. Robot.* **3**, eaar8580 (2018)

DOI: 10.1126/scirobotics.aar8580

The PDF file includes:

- Fig. S1. The fabrication of the inverse opal-structured hydrogel films.
 - Fig. S2. SEM images of the surfaces of the biohybrid structural color hydrogel films with cardiomyocyte covering.
 - Fig. S3. Results of the cardiomyocyte 3-(4,5-dimethyl-2-thiazolyl)-2,5-diphenyl-2H-tetrazolium bromide (MTT) assays.
 - Fig. S4. The typical stress-strain (stress-stretch ratio) curves of the GelMA inverse opal structural color hydrogel.
 - Fig. S5. The schematic diagram of two different approaches for regulating the structural colors of the inverse opal hydrogel films.
 - Fig. S6. The relationships of the reflectance wavelength and the stretched intensity of the GelMA inverse opal structural color hydrogel films during the stretch.
 - Fig. S7. Optical images and reflection spectra of the five different kinds of the microgroove-patterned inverse opal-structured hydrogel films.
 - Fig. S8. SEM images of the microgroove-patterned inverse opal-structured hydrogel films.
 - Fig. S9. The 3D reconstruction CLSM images of the anisotropic laminar cardiomyocyte tissues.
 - Fig. S10. Shift of the reflection spectra of the structural colors films.
- Legends for movies S1 to S4

Other Supplementary Material for this manuscript includes the following:
(available at robotics.sciencemag.org/cgi/content/full/3/16/eaar8580/DC1)

Movie S1 (.avi format). Optical images of a free-standing biohybrid structural color hydrogel (first half) and dynamic reflection spectra of the biohybrid structural color hydrogel fixed by mask mold (second half).

Movie S2 (.avi format). Optical images of a microgroove-patterned biohybrid structural color hydrogel.

Movie S3 (.avi format). Optical images of a robotic butterfly morphology structural color hydrogel flying in medium.

Movie S4 (.avi format). The bending process of a structural color heart-on-a-chip under normal medium (first half) and under isoproterenol stimulation (second half).

Supplementary figures:

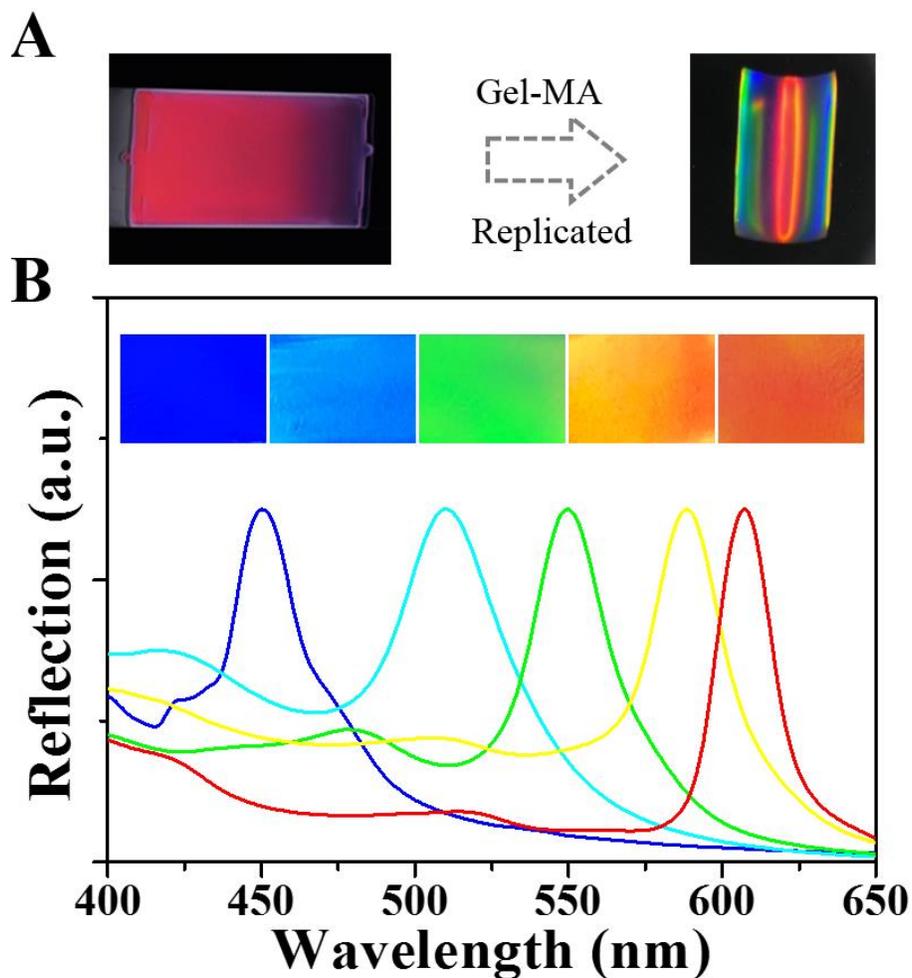


Fig. S1. The fabrication of the inverse opal-structured hydrogel films. (A) Optical images of a colloidal crystal template with silica nanoparticles self-assembling on the surface of a glass slide (left), and a replicated inverse-opal structured hydrogel film (right). (B) Images and reflection spectra of five kinds of inverse-opal structured GelMA hydrogel films. From left to right, the diameters of silica nanoparticles used for the films fabricated were 225 nm, 250 nm, 270 nm, 295 nm, and 300 nm, respectively.

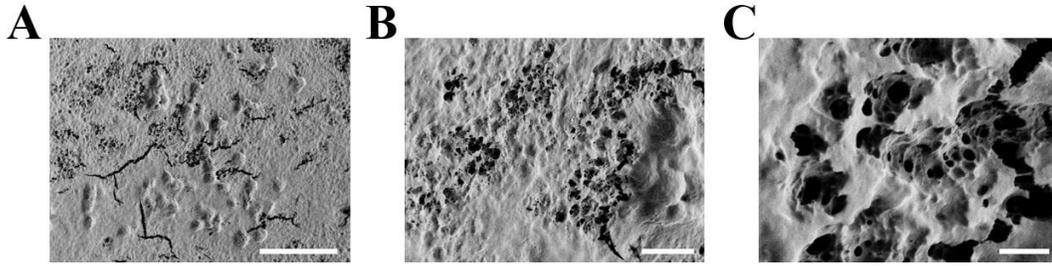


Fig. S2. SEM images of the surfaces of the biohybrid structural color hydrogel films with cardiomyocyte covering. (A, B) and (C) are the images under different magnifications. Scale bars are 50 μm in A, 10 μm in B, and 2 μm in C.

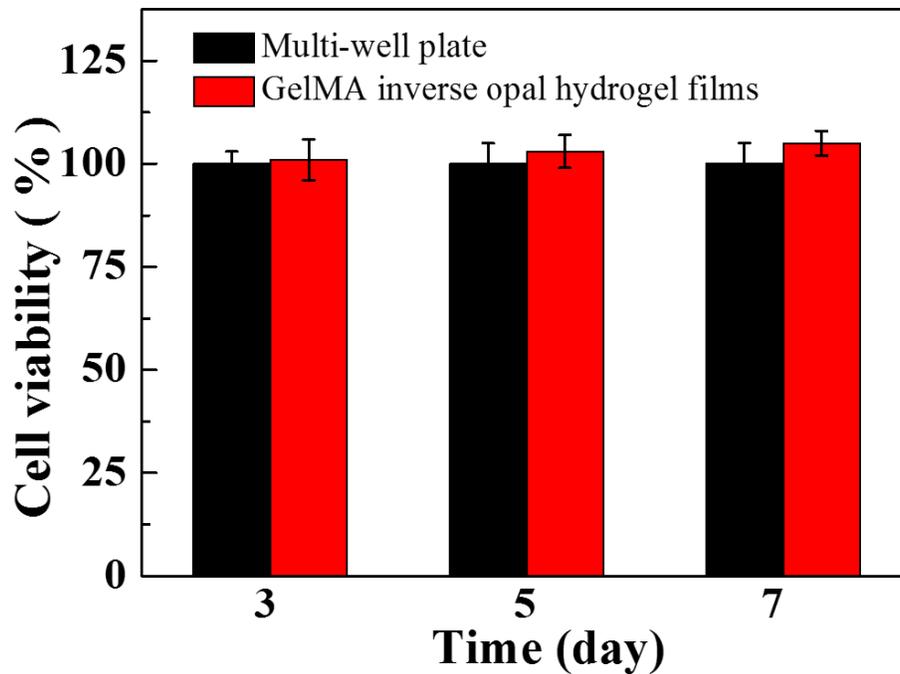


Fig. S3. Results of the cardiomyocyte 3-(4,5-dimethyl-2-thiazolyl)-2,5-diphenyl-2H-tetrazolium bromide (MTT) assays. The cardiomyocytes were cultured on multi-well plate and GelMA inverse opal structural-color hydrogels for 3 days, 5 days, and 7 days, respectively. The MTT values of the cardiomyocytes on multi-well plate in different time were set as control and the cells viability were set as 100%.

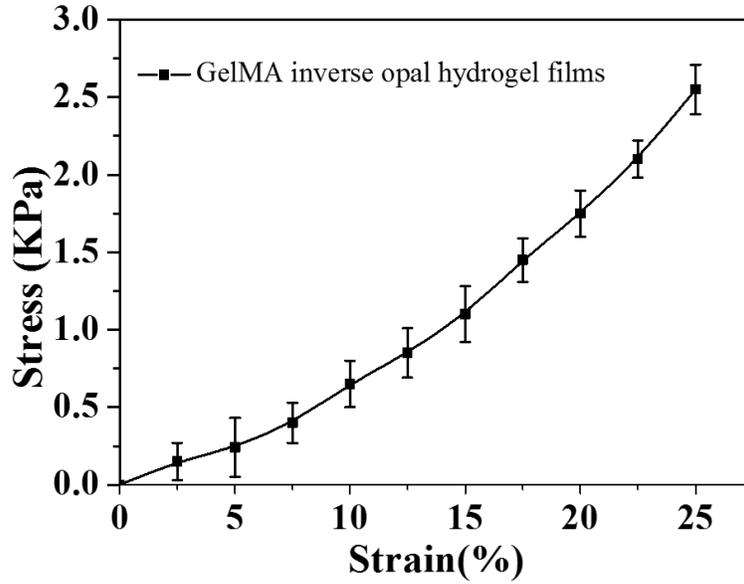


Fig. S4. The typical stress-strain (stress-stretch ratio) curves of the GelMA inverse opal structural color hydrogel.

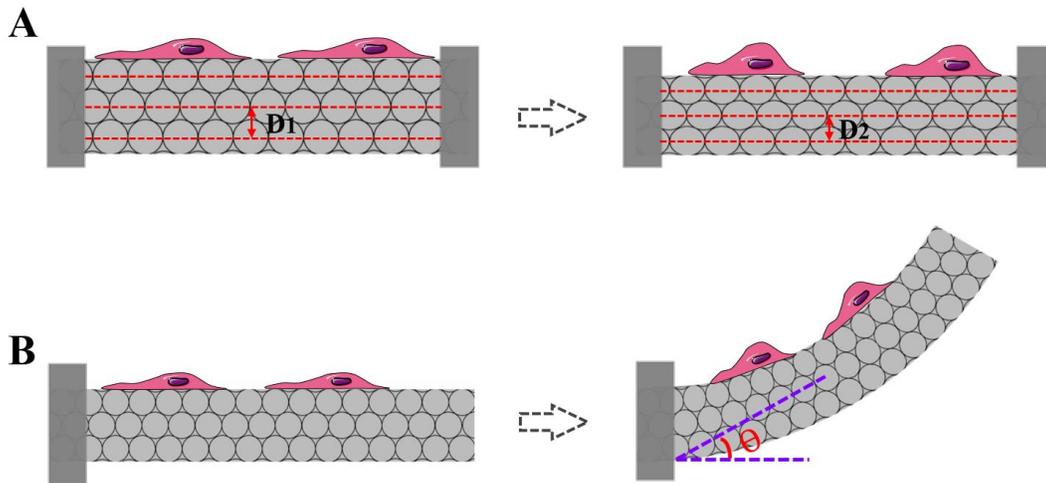


Fig. S5. The schematic diagram of two different approaches for regulating the structural colors of the inverse opal hydrogel films. **(A)** By changing the diffracting plane spacing D during the myocardial cycles. **(B)** By bending the film and changing its Bragg glancing angle θ during the myocardial cycles.

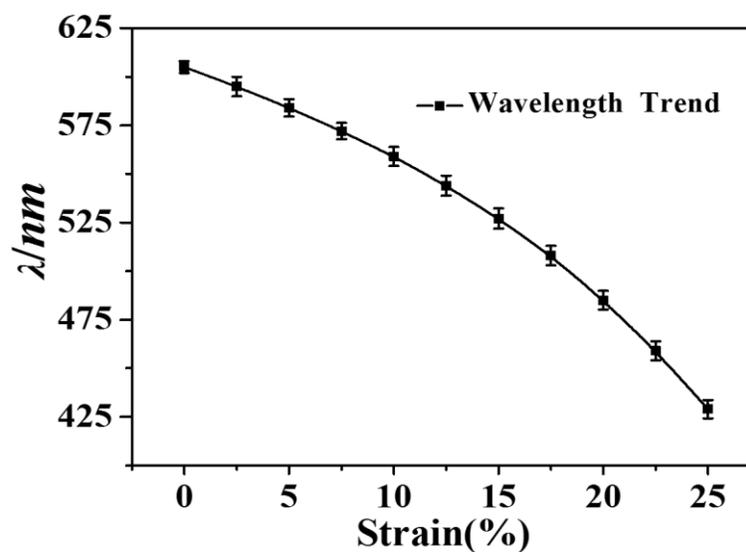


Fig. S6. The relationships of the reflectance wavelength and the stretched intensity of the GelMA inverse opal structural color hydrogel films during the stretch.

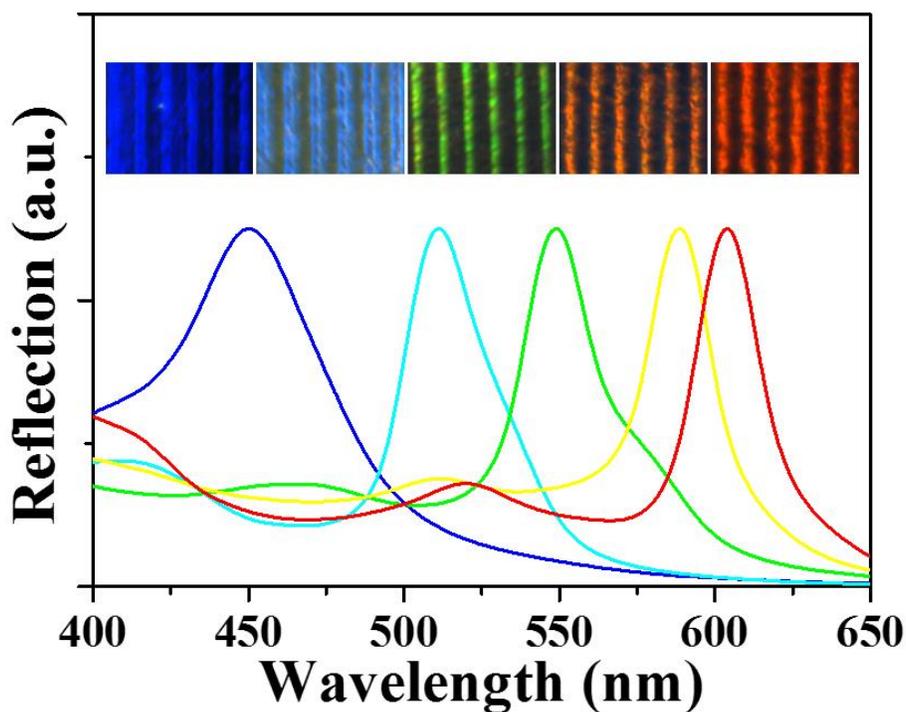


Fig. S7. Optical images and reflection spectra of the five different kinds of the microgroove-patterned inverse opal-structured hydrogel films. These films show the same structural colors and reflection peaks as their films without microgroove patterns.

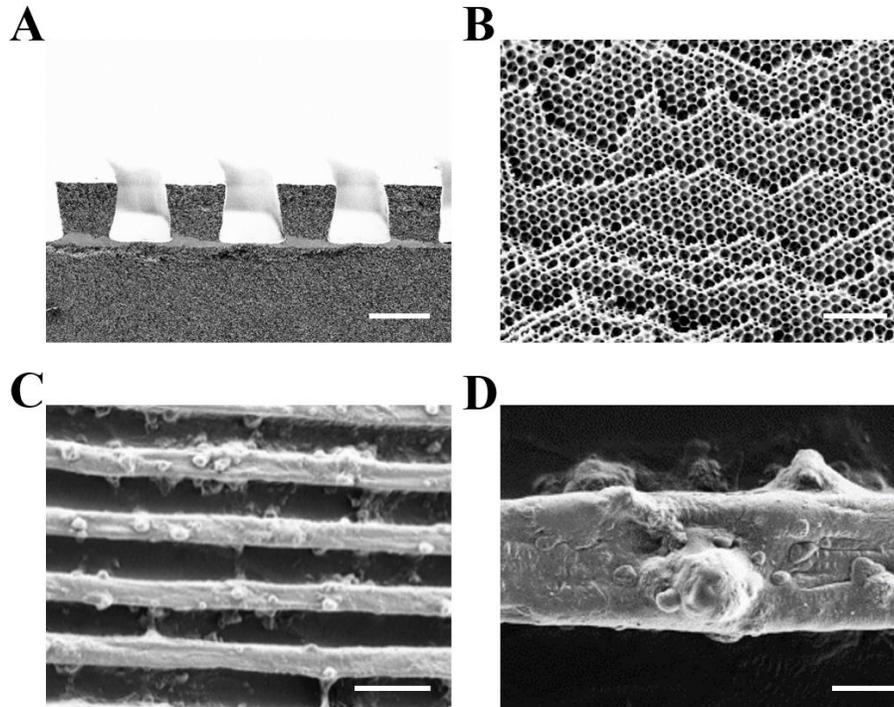


Fig. S8. SEM images of the microgroove-patterned inverse opal-structured hydrogel films. (A) Cross section of the microgroove patterned hydrogel film. (B) Magnification SEM image of A. (C) Cardiomyocytes on the surface of the microgroove patterned inverse-opal structured hydrogel films. (D) Magnification image of C. Scale bars are 30 μm in A, 2 μm in B, 50 μm in C and 10 μm in D.

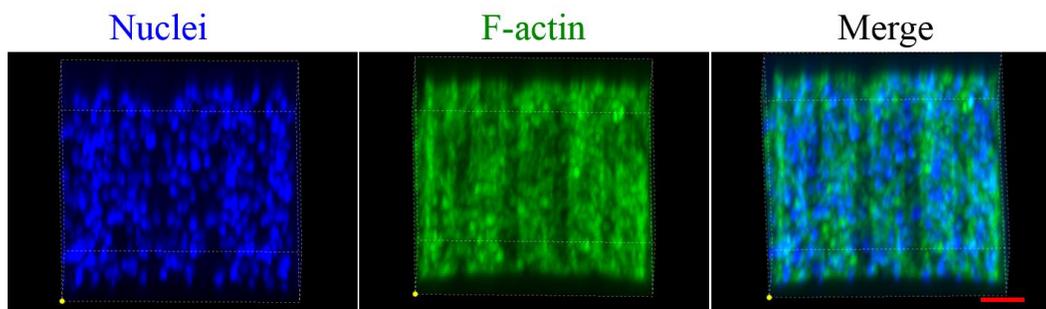


Fig. S9. The 3D reconstruction CLSM images of the anisotropic laminar cardiomyocyte tissues. The three-dimensional reconstruction CLSM images of the anisotropic laminar cardiomyocyte tissues on the surface of the microgroove patterned inverse-opal structured hydrogel films. Scale bars, 50 μm .

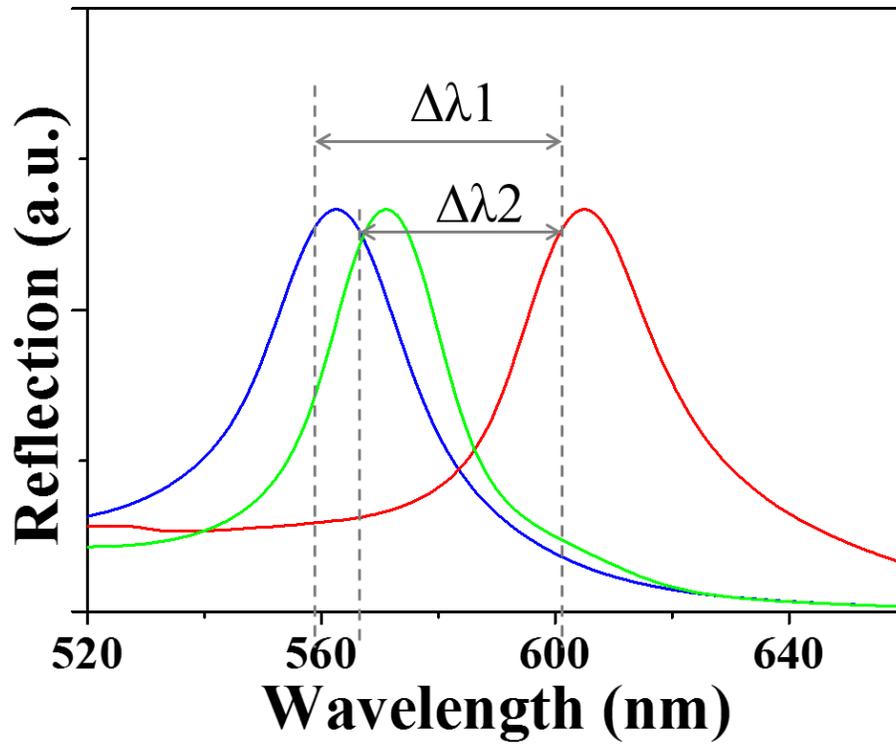


Fig. S10. Shift of the reflection spectra of the structural colors films. Shift of the reflection spectra of the microgroove patterned biohybrid structural colors film ($\Delta\lambda_1$: from the red line peak to the blue line peak). $\Delta\lambda_2$ (from the red line peak to the green line peak) is the max reflection spectra shift values of the biohybrid structural colors film without the microgroove patterned structure.

Description of Supporting Movie S1 to Movie S4

Movie S1. Optical images of a free-standing biohybrid structural color hydrogel (first half) and dynamic reflection spectra of the biohybrid structural color hydrogel fixed by mask mold (second half).

Movie S2. Optical images of a microgroove-patterned biohybrid structural color hydrogel.

Movie S3. Optical images of a robotic butterfly morphology structural color hydrogel flying in medium.

Movie S4. The bending process of a structural color heart-on-a-chip under normal medium (first half) and under isoproterenol stimulation (second half).