2019「中技社科技獎學金」

2019 CTCI Foundation Science and Technology Scholarship

境外生生活助學金

Living Grant for International Graduate Students

國立臺灣大學 National Taiwan University

Conductive self-healing hydrogels and shape-recoverable scaffolds based on chitosan derivatives

Junpeng Xu[1], Shan-hui Hsu[1,2]

[1] Institute of Polymer Science and Engineering, National Taiwan University, Taipei, Taiwan

[2] Institute of Cellular and System Medicine, National Health Research Institutes, Miaoli, Taiwan

中技社 CTCI FOUNDATION

Introduction Conductive hydrogels and scaffolds for electrically excitable cells have great potential in the biomedical field. Herein, we designed an injectable conductive hydrogel with rapid self-healing ability and a conductive shape-recoverable scaffold to promote the proliferation and differentiation of neural stem cells (NSCs). Conductivity of hydrogels and scaffolds is the contribution of conductive nanoparticles (DCP) which are generated by linking polypyrrole with modified chitosan [1]. DCP is further mixed with chitosan derivates and nano-crosslinker to produce the hydrogel and scaffold at different conditions. Conductive hydrogels and scaffolds both showed injectability and porous structure, and shape-recoverable scaffolds exhibited high water absorption and excellent structural stability. The hydrogel and the scaffold had good biocompatibility proved by cell viability of NSCs loaded in them. In addition, DCP-loaded scaffolds significantly enhanced neural differentiation of NSCs into neurons. The potential of the scaffolds in neural tissue engineering and strain sensitivity will be further evaluated by animal models and the four-point probe respectively.

Hydrogel properties

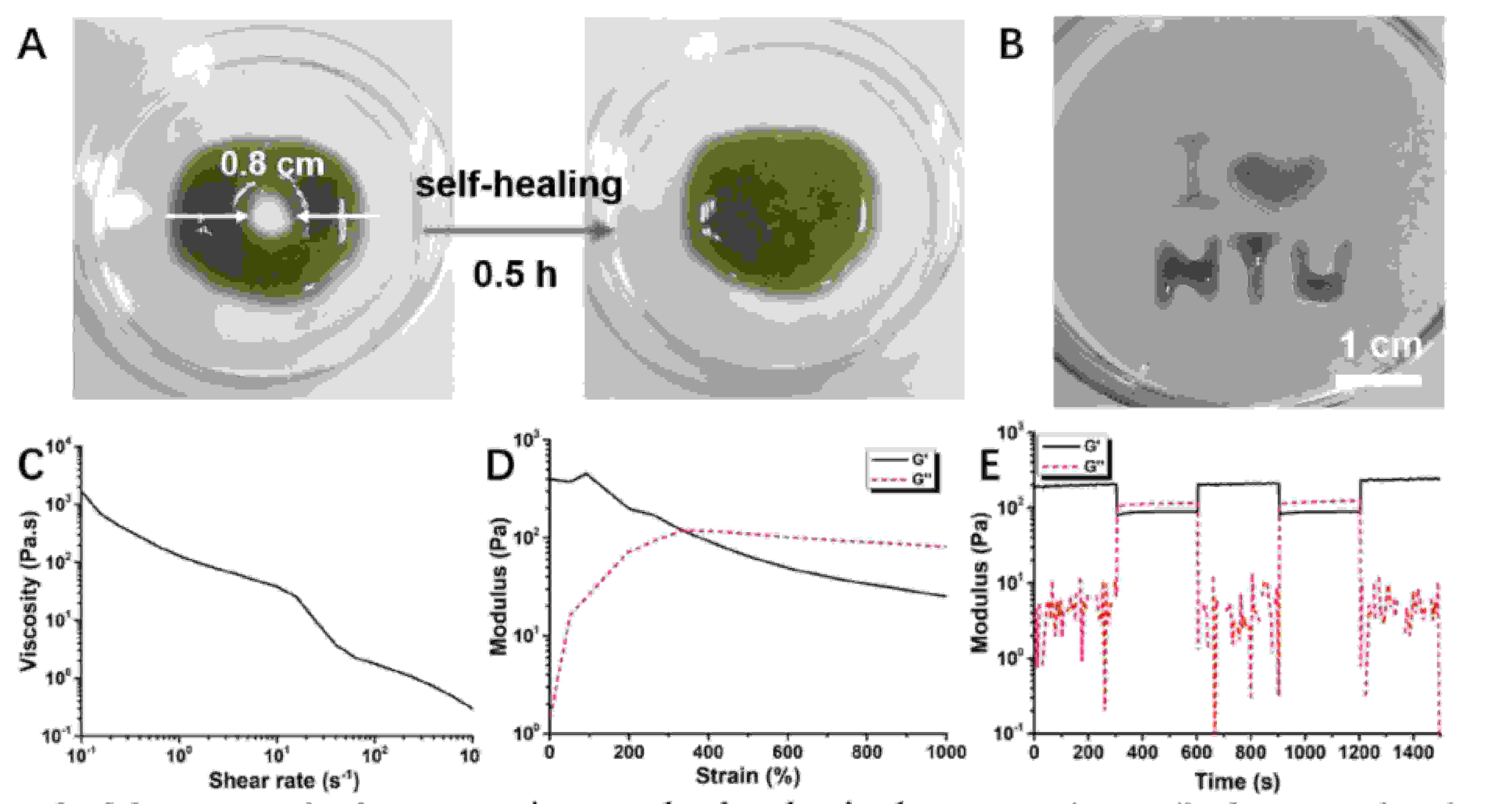

Fig. 1 Macroscopical properties and rheological properties of the conductive hydrogels, including A) self-healing property after 0.5h. B) injectability through 34G needle. C) shear thinning property. D) strain sweep, and E) damage-healing cycles. Storage modulus (G', ●), loss modulus (G'', ●).

Scaffold properties

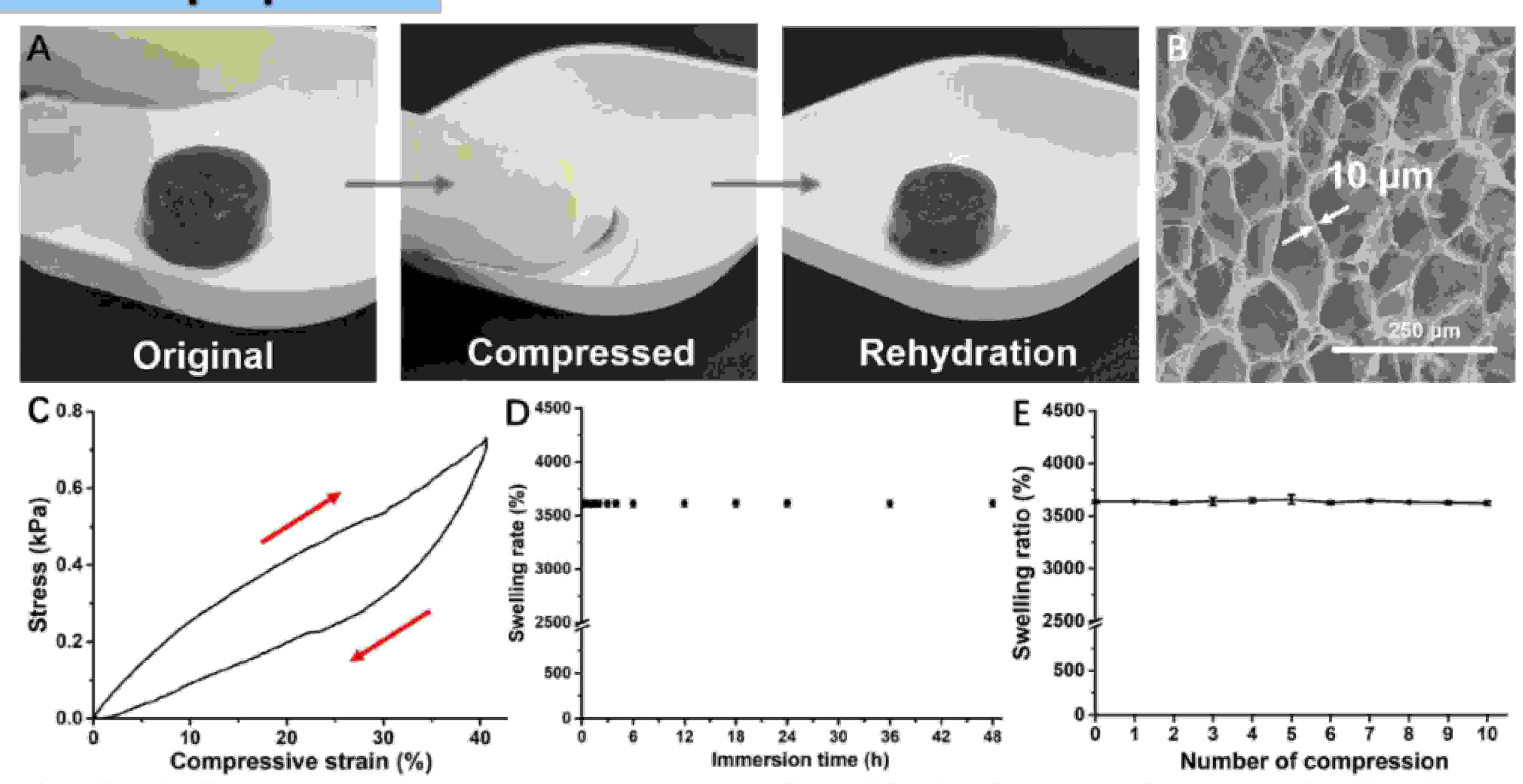

Fig. 2 A) Compression and recovery test of scaffold after rehydration. B) The SEM image of the scaffold (cross-sectional view). C) Static compression behavior (stress vs. strain). D) Swelling ratios versus the time after immersion for scaffolds, and E) Swelling ratios after multiple cycles of compression and recovery.

Conductivity

Table 1. Resistivity of CDD hydrogels and scaffolds comprising different concentrations of DCP. CDDH and CDDS are represent for conductive hydrogels and scaffolds, respectively.

Sample	DCP (wt%)	Conductivity (mS · cm⁻¹)	Sample	DCP (wt%)	Conductivity (mS · cm⁻¹)
CDDH0	0	0.88 ± 0.11	CDDS0	0	0.53 ± 0.09
CDDH5	0.1	2.54 ± 0.13	CDDS5	0.1	2.05 ± 0.19
CDDH6	0.2	3.13 ± 0.27	CDDS6	0.2	2.89 ± 0.15
CDDH3	0.3	5.85 ± 0.33	CDDS3	0.3	3.72 ± 0.28
CDDH7	0.4	4.62 ± 0.39	CDDS7	0.4	3.58 ± 0.31
CDDH8	0.5	4.20 ± 0.26	CDDS8	0.5	3.62 ± 0.27

Cell viability

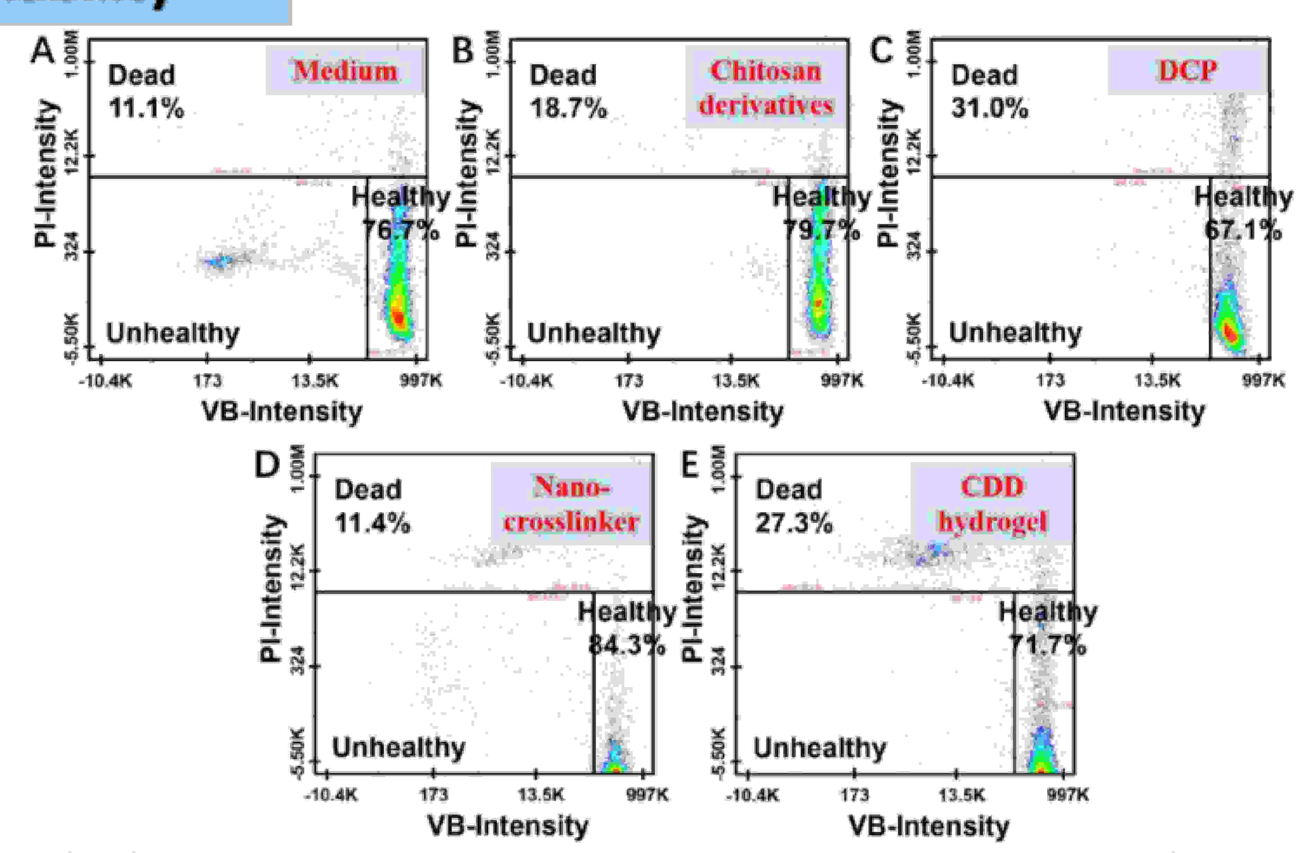

Fig. 3 Cell vitality analyzed by the VB-48TM assay: (A) cell medium, (B) chitosan derivatives, (C) DCP, (D) nano-crosslinker, and (E) CDD hydrogel.

Conclusion All the results demonstrated both CDD hydrogels and scaffolds have good physicochemical properties, biocompatibility, and enough conductivity. CDD conductive hydrogels and scaffolds developed in this study may be potential materials for neural engineering and wearable electronics.

Reference [1] Darabi, Mohammad Ali, et al. "Skin-inspired multifunctional autonomic-intrinsic conductive self-healing hydrogels with pressure sensitivity, stretchability, and 3D printability." Advanced Materials 29.31 (2017): 1700533.

財團法人中技社 CTCI FOUNDATION