

## Supplementary file

### Hierarchically Engineered Injectable Hydrogel loaded with polyphenol for Enhanced Wound Healing and Tissue Regeneration

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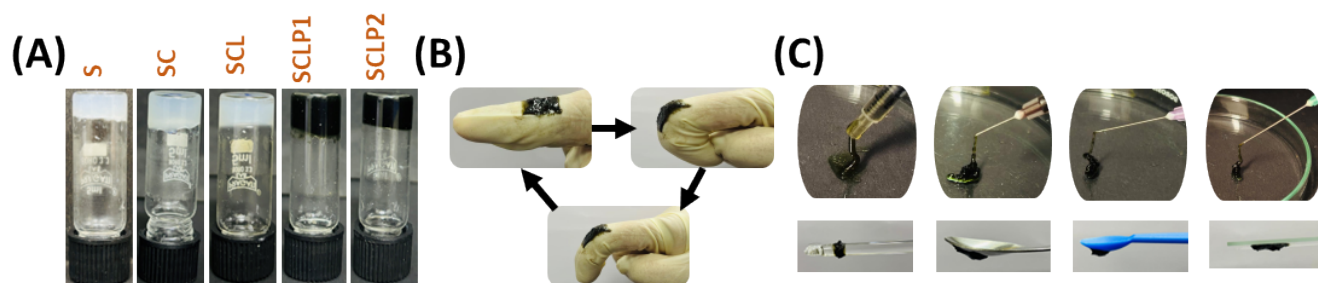


Figure S1 (A) Photographs of each formulation: S (control), SC, SCL, SCLP1, and SCLP2, demonstrating differences in appearance. (B) Visual demonstration of hydrogel flexibility and cohesive strength (C). Visual demonstration of hydrogel injectability and adhesion over different materials

(A)

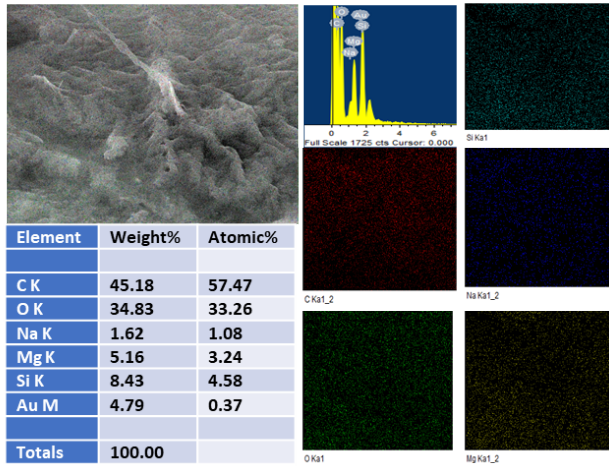
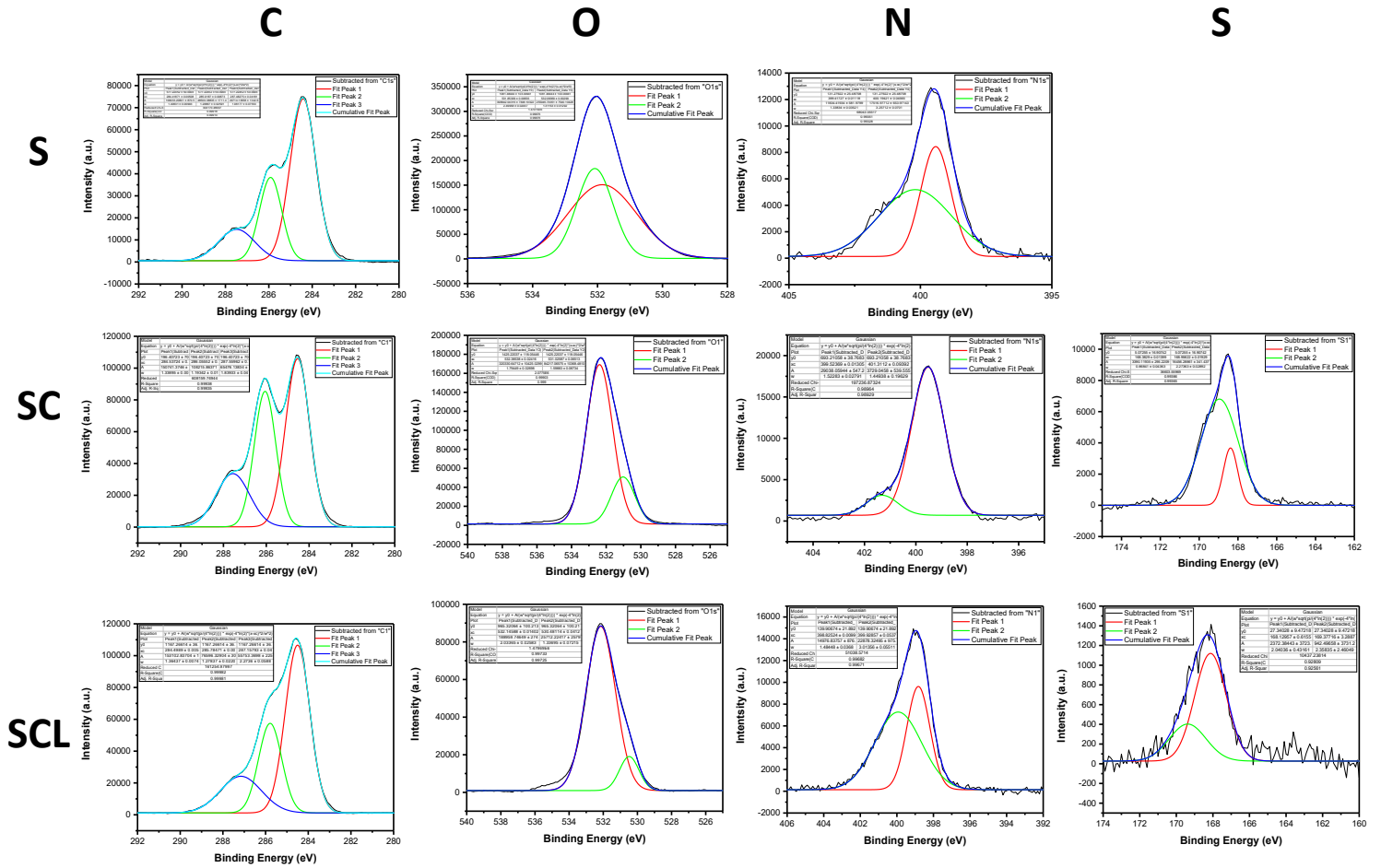


Figure S2 (A) SEM image coupled with Energy Dispersive X-ray Spectroscopy (EDS) mapping



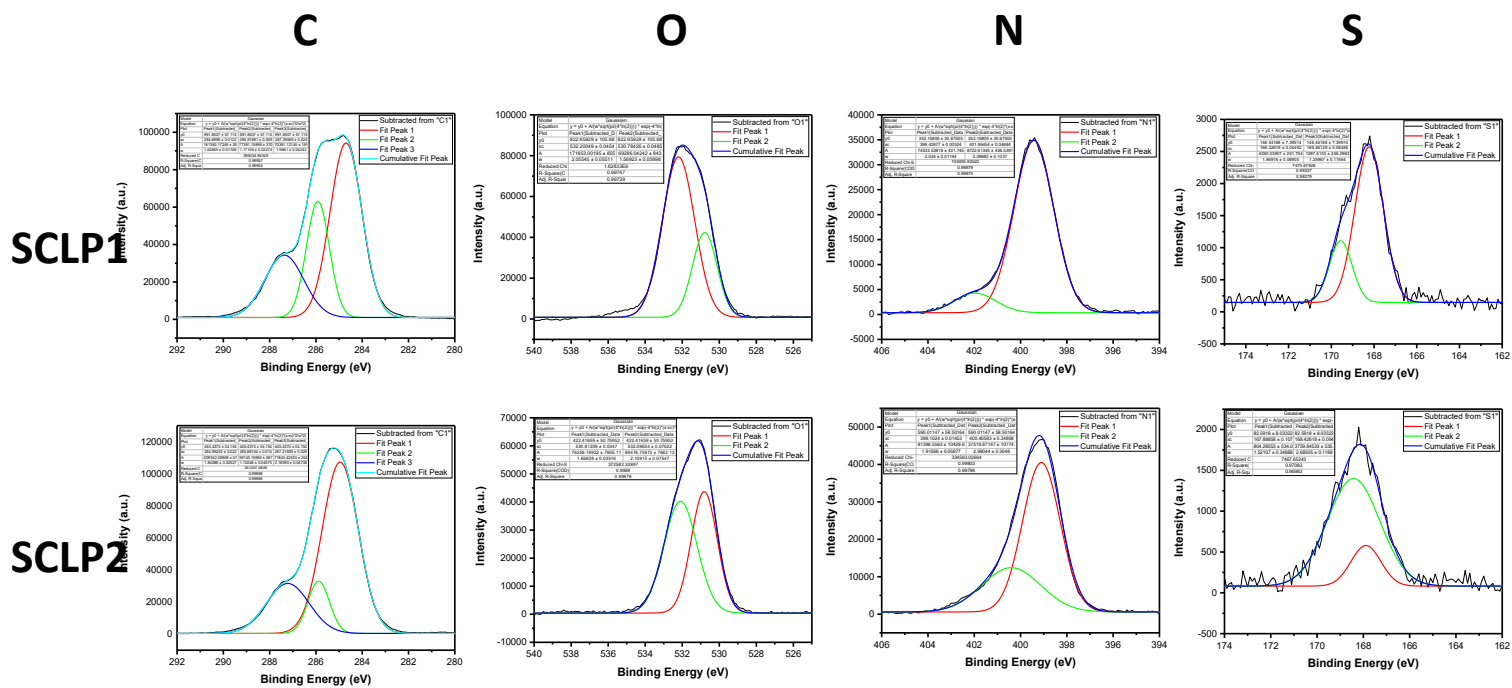


Figure S3 High-resolution XPS scanning C, O, N, and S elements for each formulation to display the chemical bonding between them.

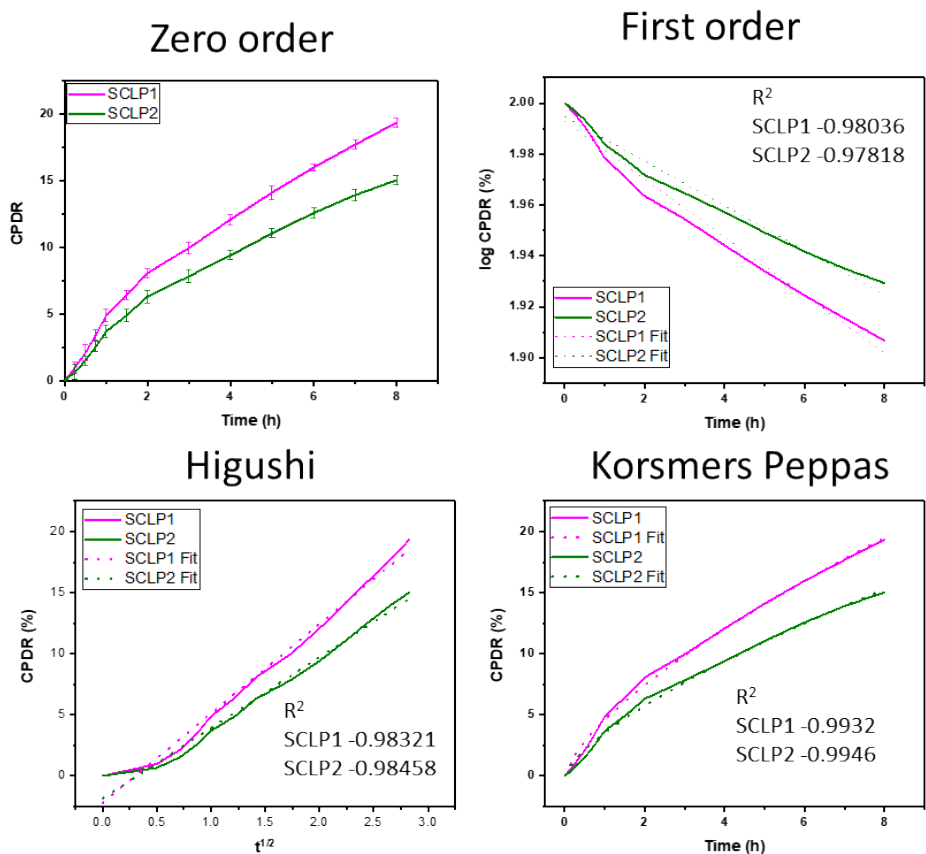


Figure S4 Drug release kinetic models

Table S1 Drug release model equations for kinetic models.

Model Name	Equation	Explanation
Zero order	$M_t = M_0 + k_0 t$	$M_t$ = amount of drug released at “t”, $M_0$ = amount of drug encapsulated $K_H$ , $K$ , and $K_0$ and $n$ are constants.
First order	$\log(M_0 - M_t) = \log M_0 - 2.303 k t$	
Higuchi model	$M_t = K_H t^{1/2}$	
Korsmers Peppas	$M_t = K * t^n$	

Table S2 Regression coefficient (R2) value for PCA release from SCLP1 and SCLP2 hydrogel sample from various kinetic models.

Model Name	SCLP1	SCLP2
Zero order	0.972	0.971
First order	0.9804	0.9782
Higuchi model	0.9846	0.9846
Korsmers Peppas	0.9932	0.9946

Table S3 Model Parameter values of KP for PCA release from SCLP1 and SCLP2 hydrogel samples

	Model parameter	SCLP1	SCLP2
KP Model	K (Diffusion constant)	4.601271	3.528283
	n (Exponent constant)	0.69452	0.70569
	R <sup>2</sup>	0.9932	0.9946

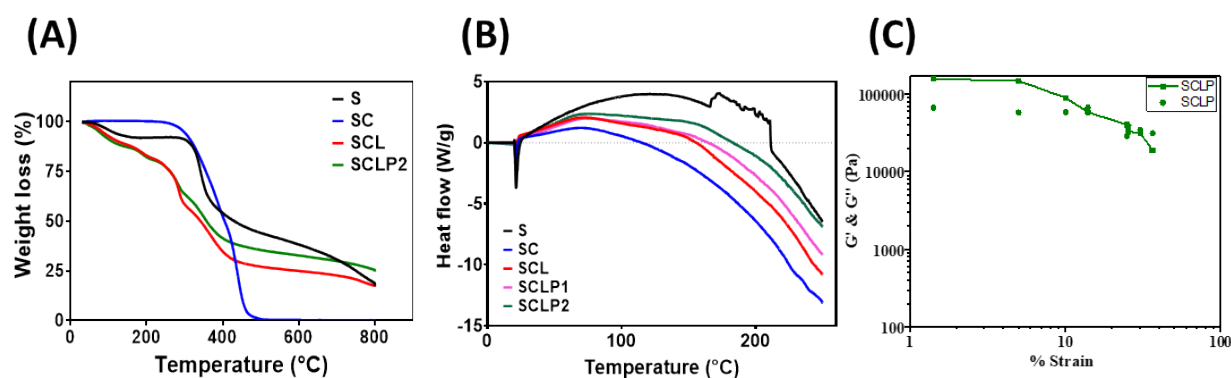


Figure S5. Thermal and rheological characterization of hydrogel composites. (A) Thermogravimetric analysis (TGA) curves showing weight loss, (B) Differential Scanning Calorimetry (DSC) thermograms showing heat flow (W/g) versus temperature, and (F) Strain-dependent variation of storage (G') and loss (G'') moduli for SCLP and SCLP2 hydrogels