

Supporting Information

Self-Regulating Wearable OLED Patch for Accelerated Wound Healing via Photobiomodulation-Triggered Drug Delivery

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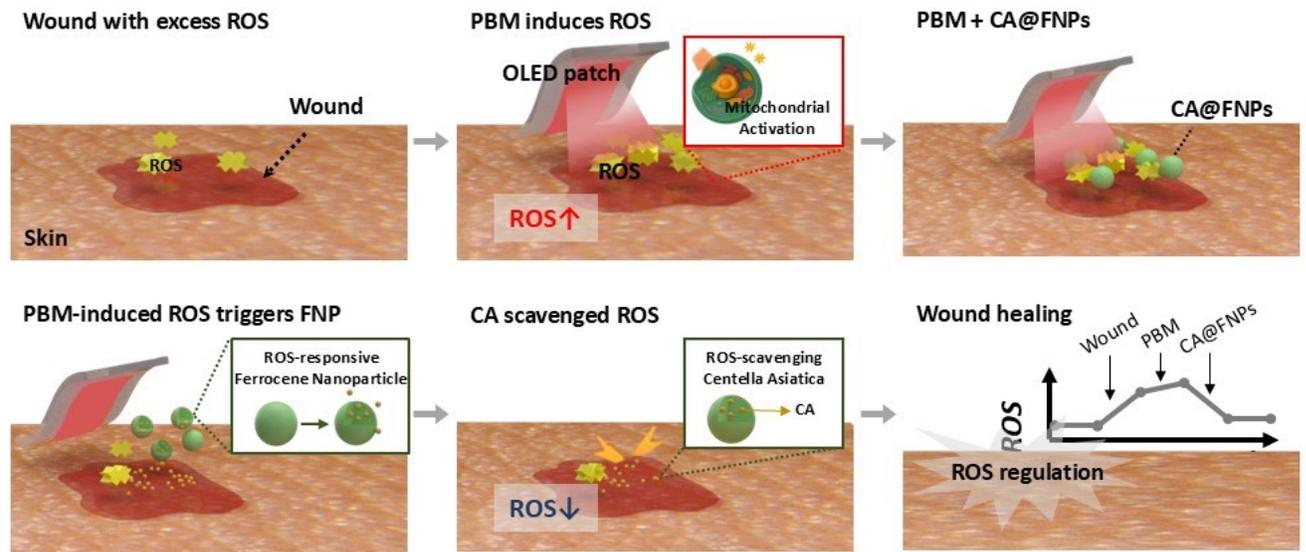
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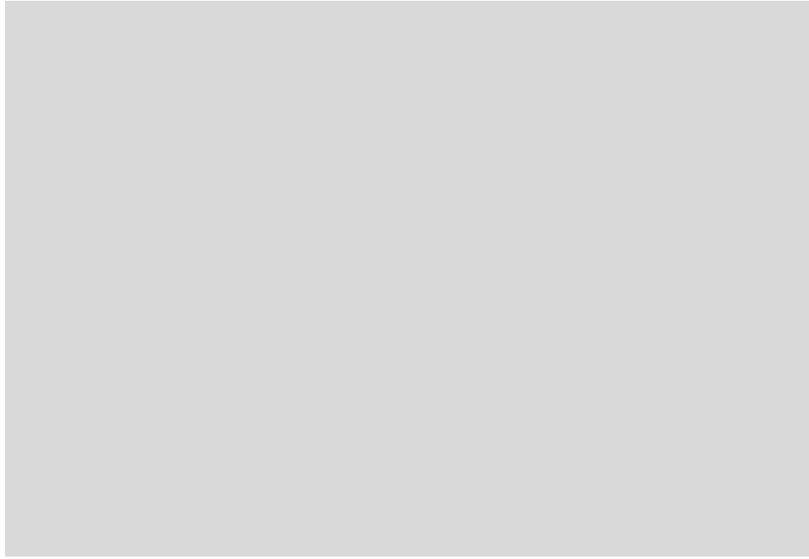
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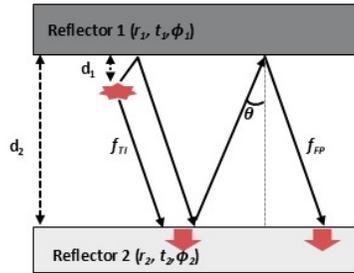


Supplementary figure 1. ROS-regulated process with OLED-based PBM and PBM-triggered CA@FNPs



Supplementary figure 2. Schematic illustration of fabrication process

(a)



$$\Delta\phi_{FP} = -\phi_1 - \phi_2 + nk_0 2d_2$$

$$R = |r_1| \cdot |r_2| \cdot e^{-\kappa k_0 2d_2}$$

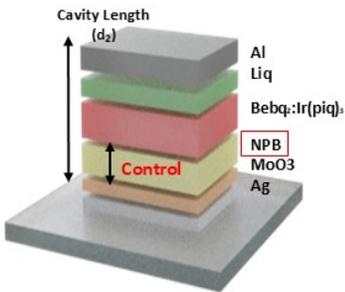
$$f_{FP}(\lambda) = \frac{|t_2|^2}{(1-R)^2 + 4R(\sin \frac{\Delta\phi_{FP}}{2})^2}$$

$$f_{T1}(\lambda; d_1) = 1 + (|r_1| \cdot e^{-\kappa k_0 2d_1})^2 + 2 \cdot |r_1| \cdot e^{-\kappa k_0 2d_1} \cdot \cos \Delta\phi_{T1}$$

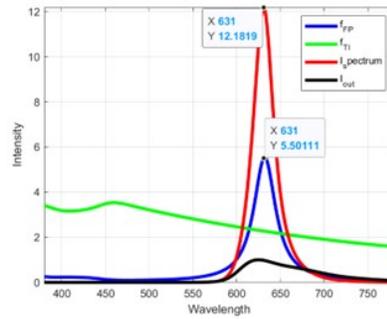
$$G_{cav}(\lambda) = f_{FP}(\lambda) \cdot f_{T1}(\lambda; d_1)$$

$$EL_Intensity = G_{cav}(\lambda) \times I_spectrum$$

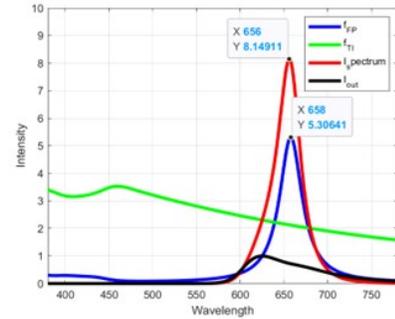
(b)



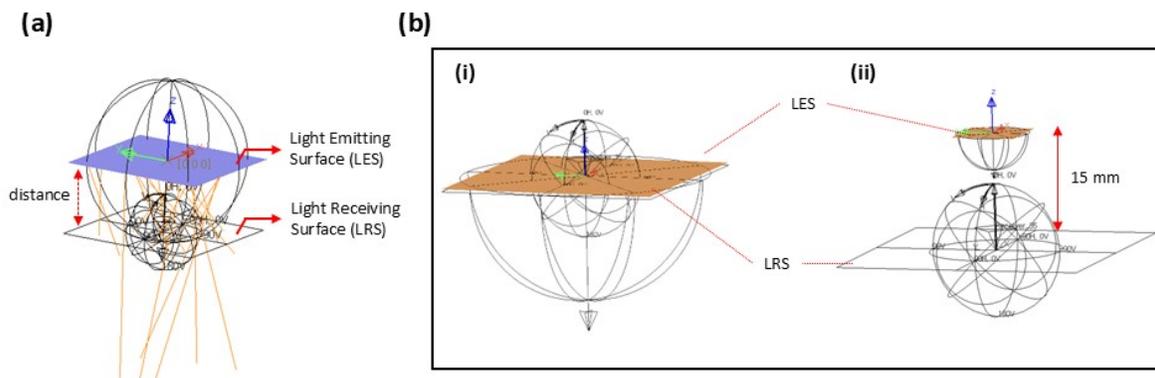
(c)



(d)



Supplementary figure 3. Matlab simulation to optimize thickness of OLED patch (a) theoretical microcavity effect (b) structure of OLED (c) NPB 62 nm (d) NPB 70 nm



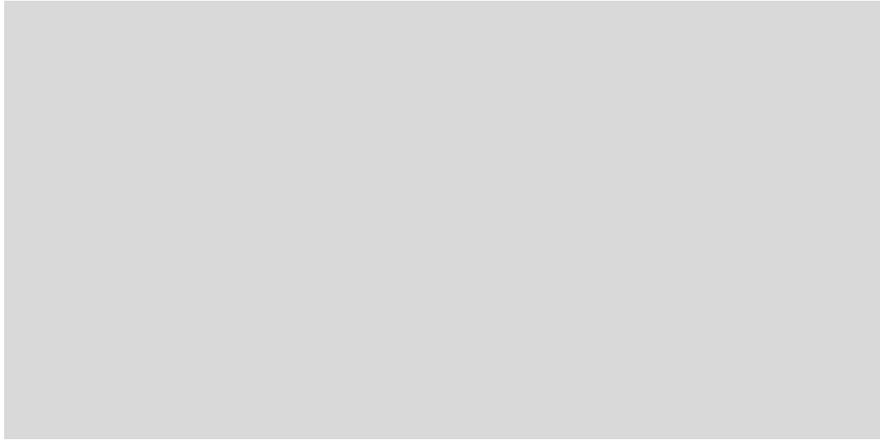
Supplementary figure 4 Ray-tracing simulation using the LightTools. The images of modeling for (a) Intensity depending on light source to target distance (related to figure 2e) (b-i) in vivo test an of the modeling without gap (b-ii) in vitro test image with air gap

To establish the effective radiant exposure of the light source for this study, an optical simulation was performed. In the simulation, a square OLED device with an area of 69 mm^2 , identical to the one used in the actual experiments, was modeled as the light source. A realistic light distribution was achieved by applying a central wavelength of 630 nm (FWHM 38 nm) and the actual device's angular intensity data. Using a normalized intensity (Intensity=1), we analyzed the light transfer efficiency at a distance of 15 mm between the light source and the receiving surface, mimicking the *in vitro* cell experiment setup which utilized a jig. The simulation results indicated a light transfer efficiency of 66.47% at this distance, confirming that only approximately 66.47% of the total light emitted from the source reached the cells. Based on this, we calculated that although the radiant exposure from the OLED patch's emitting surface was 9 J/cm^2 in the preceding *in vitro* experiment, the effective radiant exposure that actually reached the cells was approximately 6 J/cm^2 ($9 \text{ J/cm}^2 \times 0.6647$). Therefore, for the subsequent *in vivo* animal experiment, the final radiant exposure was set to 6 J/cm^2 —despite

the source being directly attached to the skin—to ensure the consistency of results by matching the effective dose with the *in vitro* study.

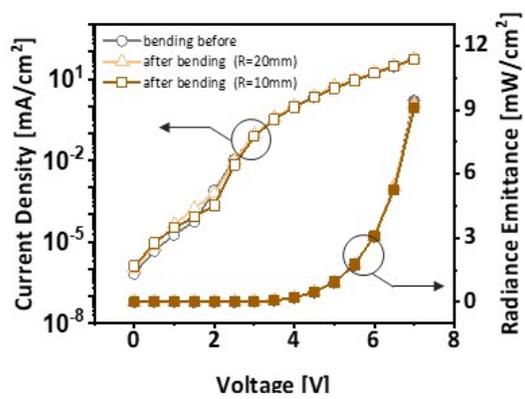


Supplementary figure 5 Angular dependency of OLED applied to microcavity. Angular dependence of (a) normalized EL spectra and (b) normalized radiant emittance.



Supplementary figure 6. Image of OLED operating temperature before and after 40 min under 5 mW/cm²

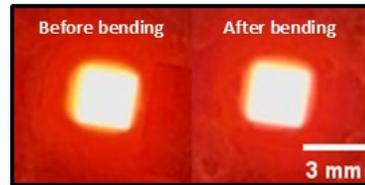
(a)



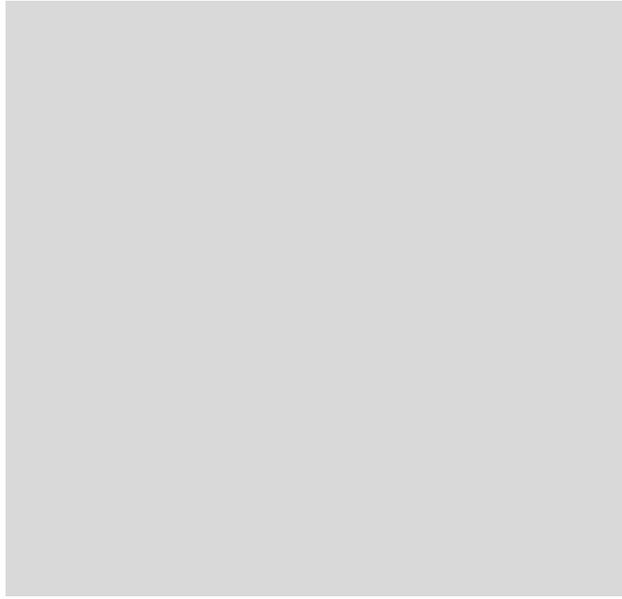
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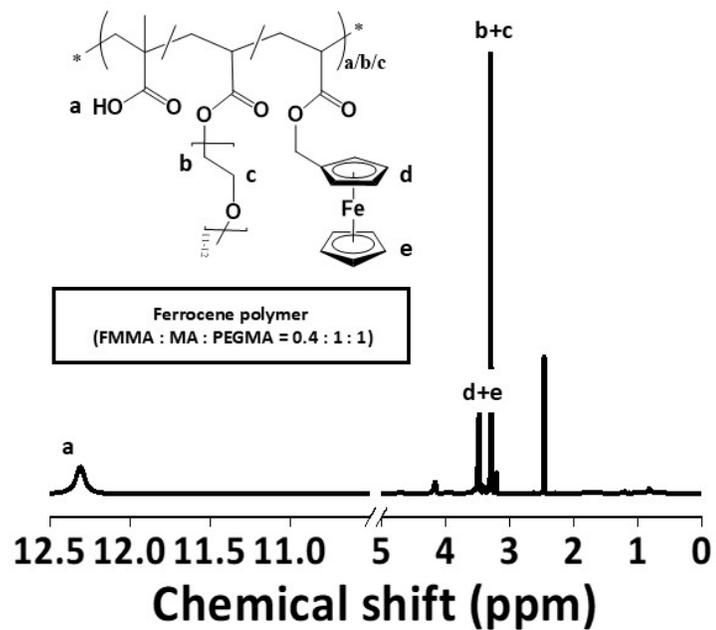
(c)



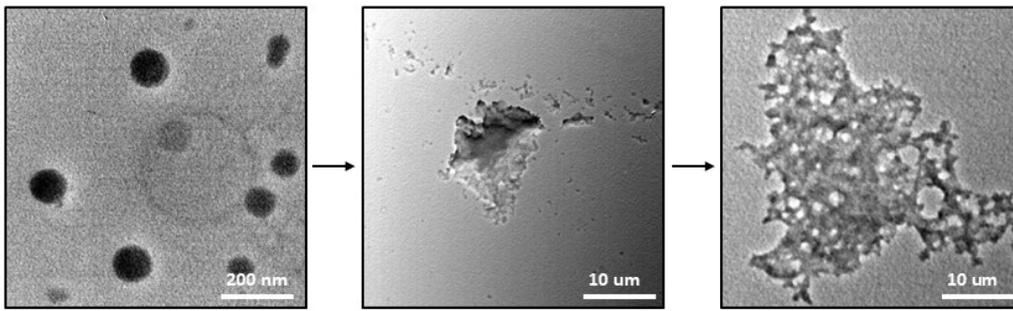
Supplementary figure 7. Performance of the OLED patch under repeated bending. (a) Comparison of electroluminescent and electrical characteristics before and after bending. (b) Photograph of the bending test setup. (c) Emission images of the OLED patch during operation.



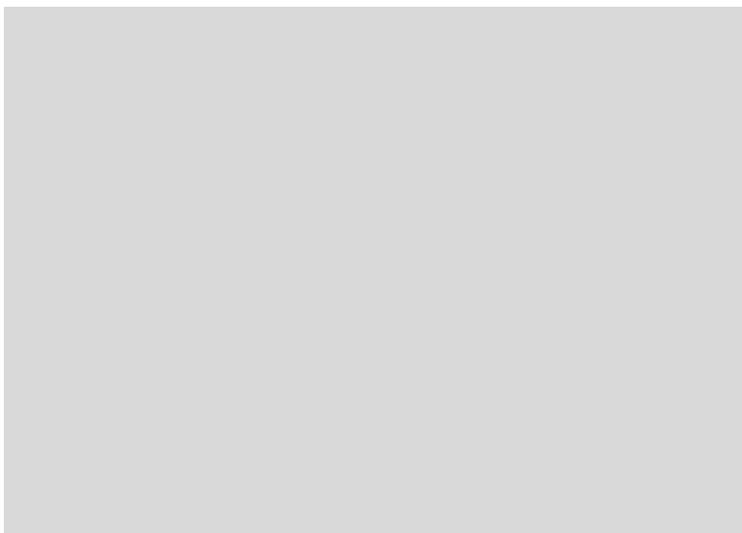
Supplementary figure 8. Comparison of performance before and after immersion in water for 1 hour.



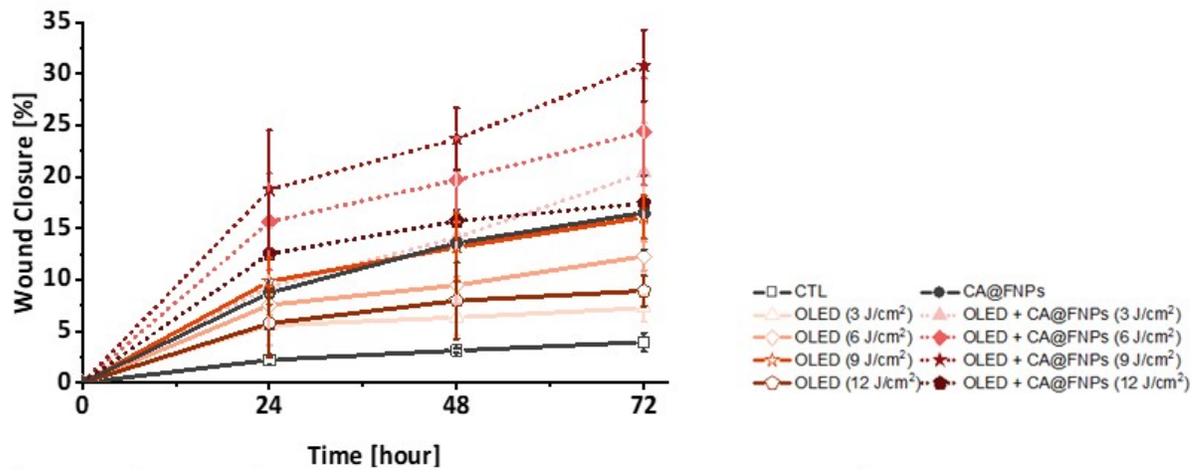
Supplementary figure 9. NMR spectra of ferrocene based on polymer (poly(FMMA-r-PEGMA-r-MA))



Supplementary figure 10. TEM images of FNPs rupture process after ROS exposure



Supplementary figure 11. In vitro cytotoxicity test of CA-load FNPs for optimization in vitro test
Data are presented as mean \pm SD (n = 3). *p < 0.05, **p < 0.01, ***P \leq 0.005 relative to the control group



Supplementary figure 12. Cell migration test over 72 hours treated with PBM and CA@FNPs

Polymer groups	Monomer feed (mol%)			Polymer feed (mol%)			Conversion (%)	M _w (g/mol)	M _n (g/mol)	D _M
	FMMA	MA	PEGMA	FMMA	MA	PEGMA				
Ferrocene polymer	16.7	41.7	41.7	21.5	31.9	46.6	99.9	22,101	11,562	1.91

Supplementary Table 1. NMR spectra of ferrocene based on polymer (poly(FMMA-r-PEGMA-r-MA))

Time [hours]	CTL	CA@FNPs	PBM				PBM + CA@FNPs			
			2 J/cm ²	4 J/cm ²	6 J/cm ²	8 J/cm ²	2 J/cm ²	4 J/cm ²	6 J/cm ²	8 J/cm ²
24	*	-	*	**	*	-	-	*	*	*
48	***	*	*	***	*	-	-	*	***	*
72	*	*	*	**	**	*	*	*	**	*

Supporting Table 2. Static processing p-value : cell migration test over 72 hours treated with PBM and CA@FNPs Data are presented as mean ± SD (n = 3). *p < 0.05, **p < 0.01, ***P ≤ 0.005, ****P ≤ 0.001 relative to the control group