Supplementary Information

Wearable Surface-Lighting Micro-Light-Emitting Diode (μLED) Patch for Melanogenesis Inhibition

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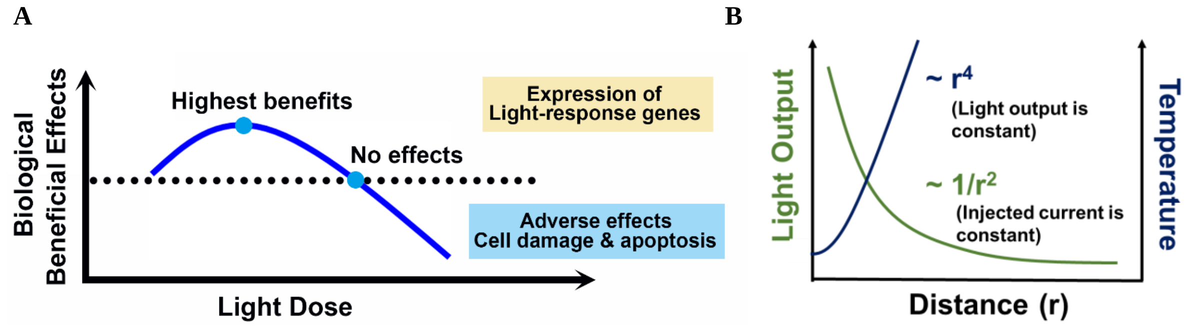

Biological Effects	Light Source	Wavelength (nm)	Ref
Melanocytes proliferation & differentiation	He-Ne laser	632.8	(15), (16)
Migration and proliferation of melanocytes	He-Ne laser	632.8	(10)
No change in pigmentation	LED	630	(12)
Not suppression of B16 melanoma 4A5 Cells	LED	634	(11)
Melanin synthesis inhibition	LED	660	(13)
Melanin synthesis inhibition	LED	830, 850	(14)

Table S1 (A) Biphasic dose response and different biological effects on melanin synthesis after red light irradiation. (B) Light output (constant current injection) and junction temperature (constant light output) with increasing irradiation distance. To maintain LED light output regardless of distance, more current must be injected, resulting in thermal damage issues due to high heat generation.

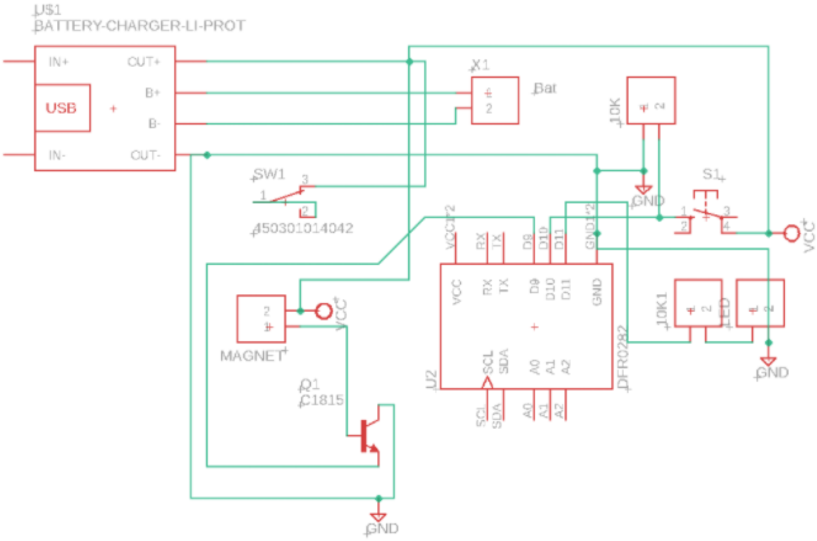

fig. S2 A circuit diagram of controller with pulse width modulation (PWM).

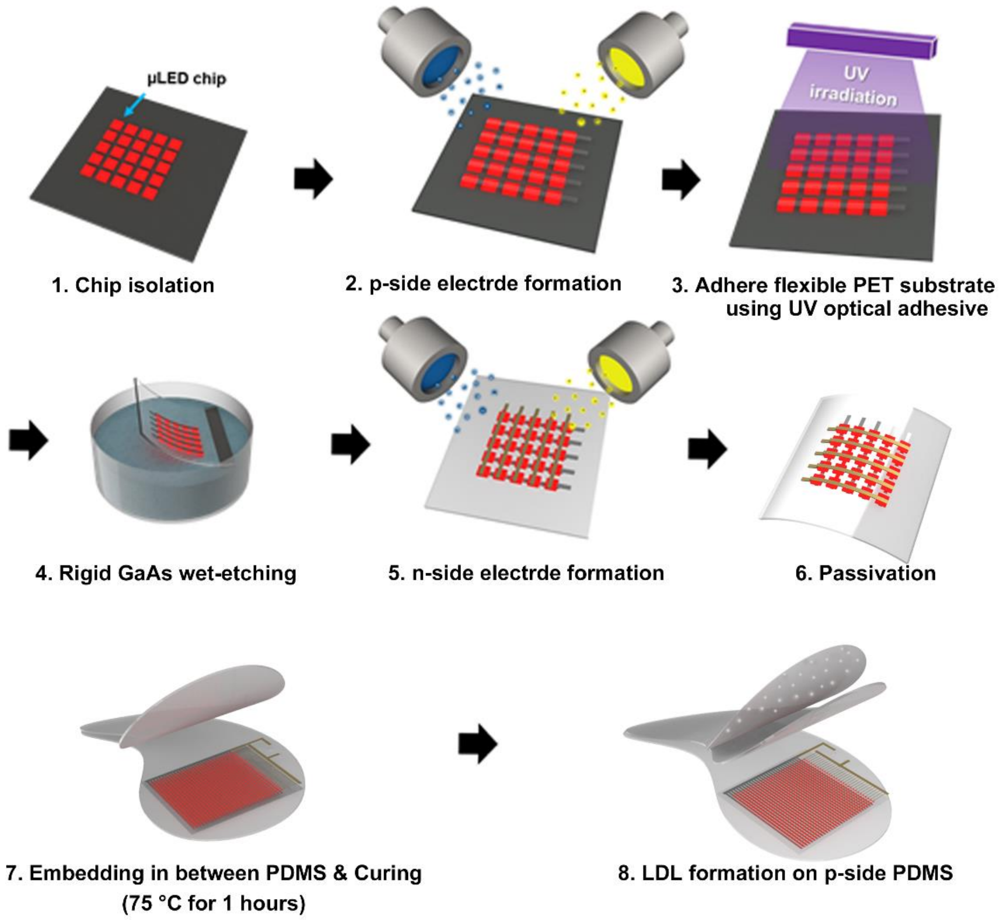

fig. S3 Schematic images of SμLEDs fabrication process.

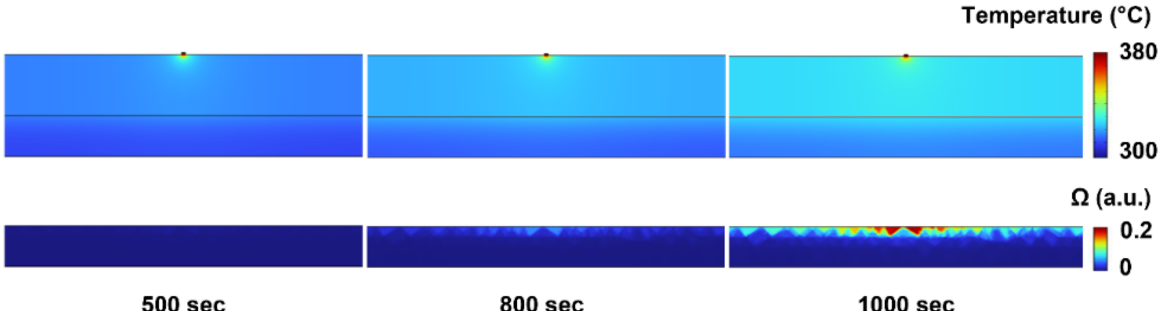

fig. S4 Temperature distributions and tissue damages by CLED at 500, 800, and 1000 seconds.

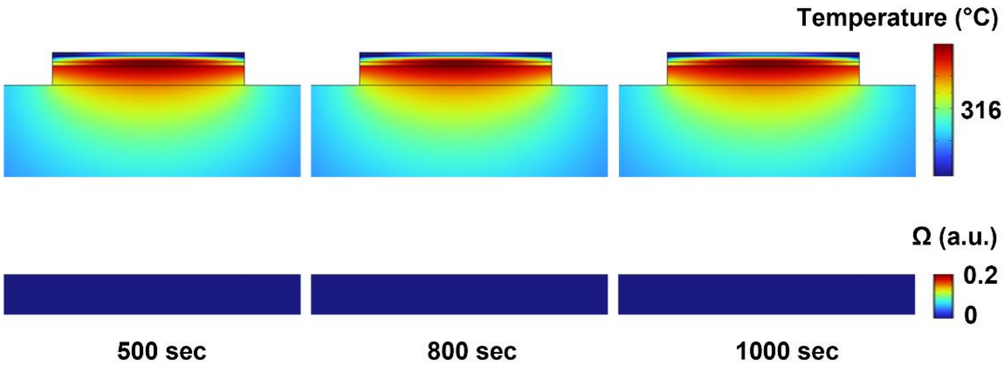

fig. S5 Temperature distributions and tissue damages by SµLED at 500, 800, and 1000 seconds.

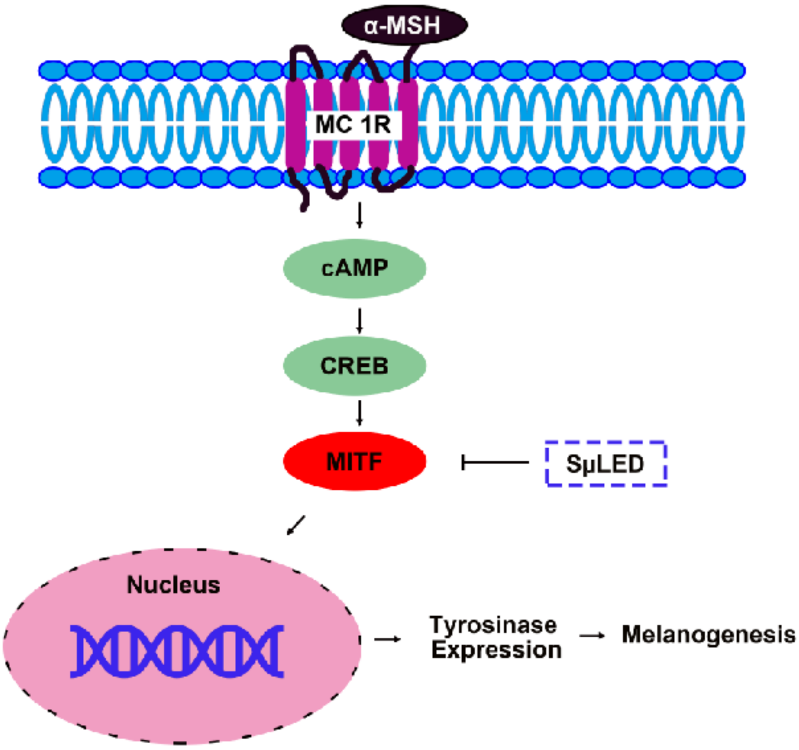

fig. S6 Conventional melanogenesis signaling pathway initiated by α-MSH.

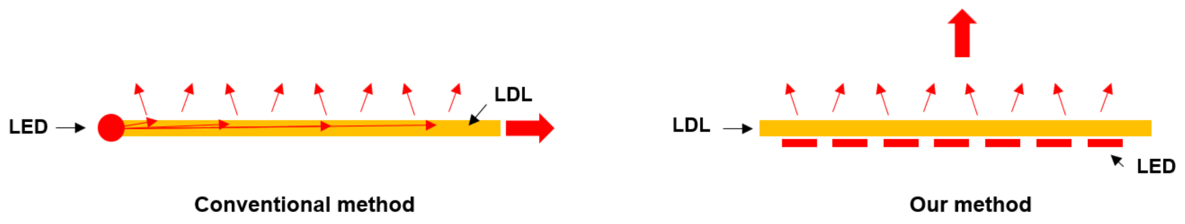

fig. S7 Schematic images to explain difference of conventional surface emitting LEDs and our SμLEDs.

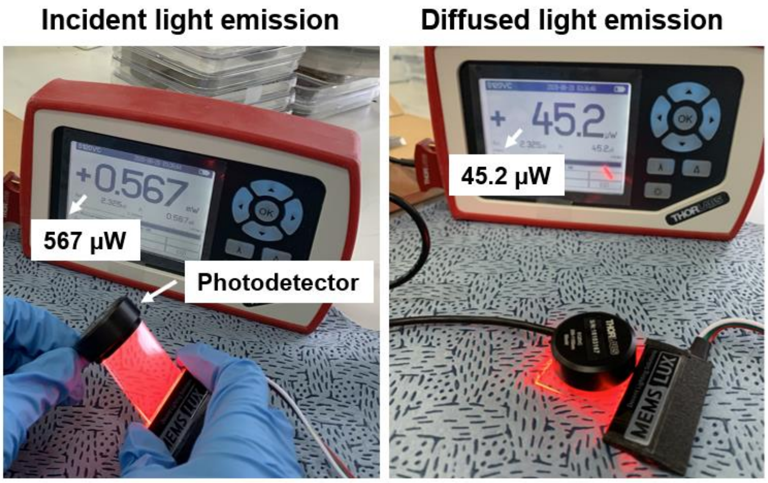

fig. S8 Optical power loss of conventional light diffusion method after passing through the LDL.

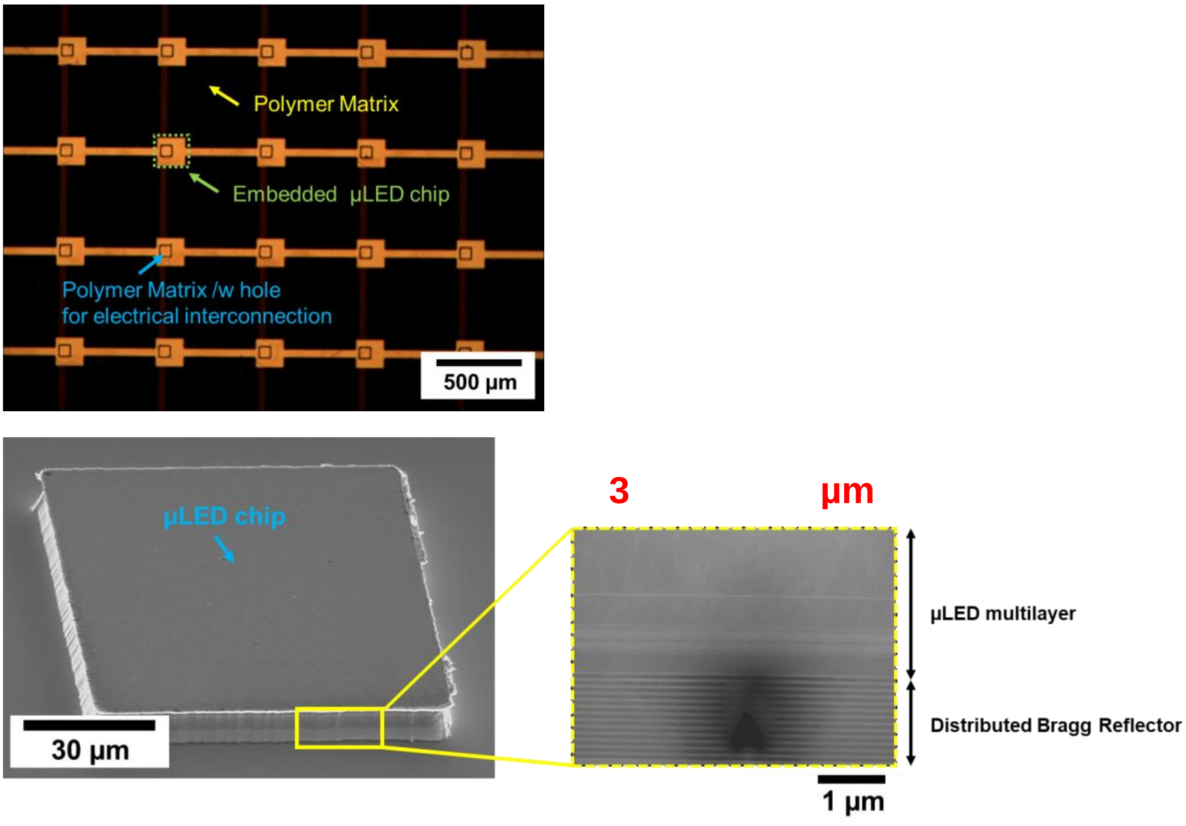

fig. S9 A optical microscopy image of µLED chips embedded into polymer matrix (top), and SEM and transmission electron microscopy (TEM) image of thin-film µLED.

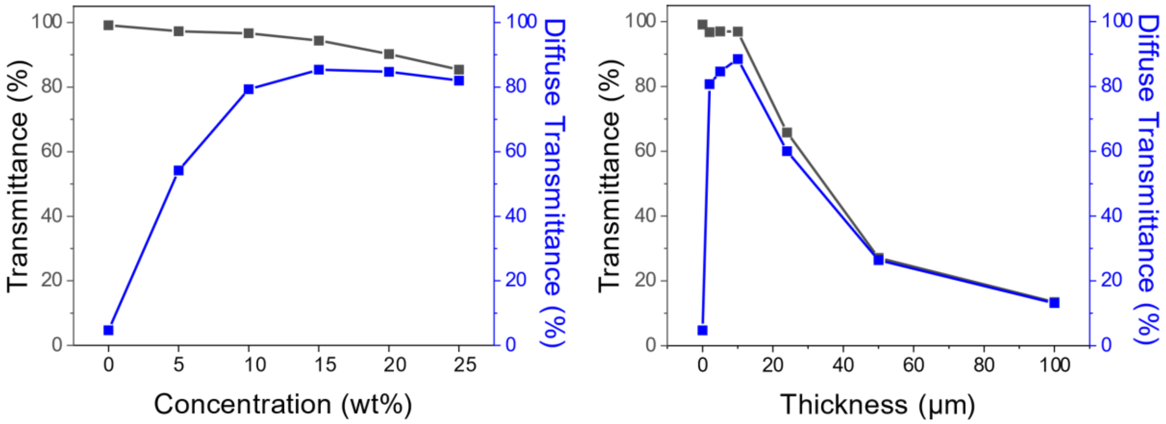

fig. S10 Total transmittance (T_t) and diffuse transmittance (T_d) of LDL depending on the silica concentration (left) and layer thickness (right).

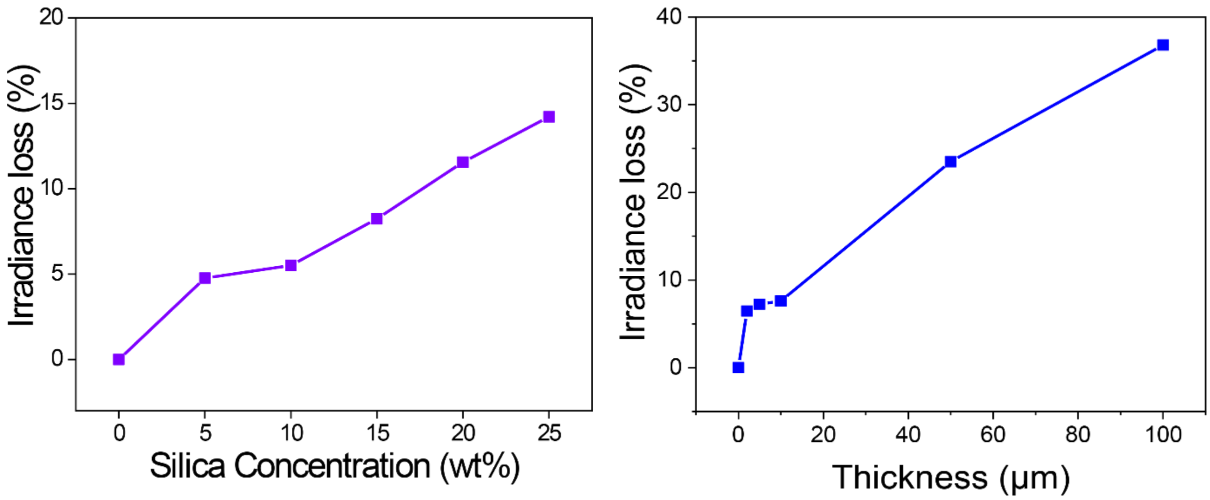

fig. S11 Irradiance loss by LDL depending on silica concentration (left), and layer thickness (right**).**

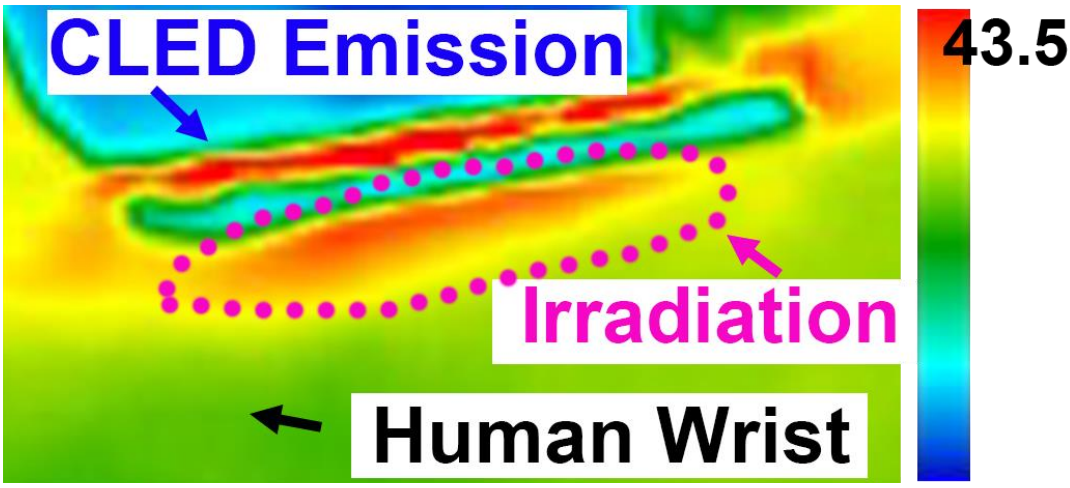

fig. S12 Thermal image of non-contact high power CLED irradiated on the human wrist.

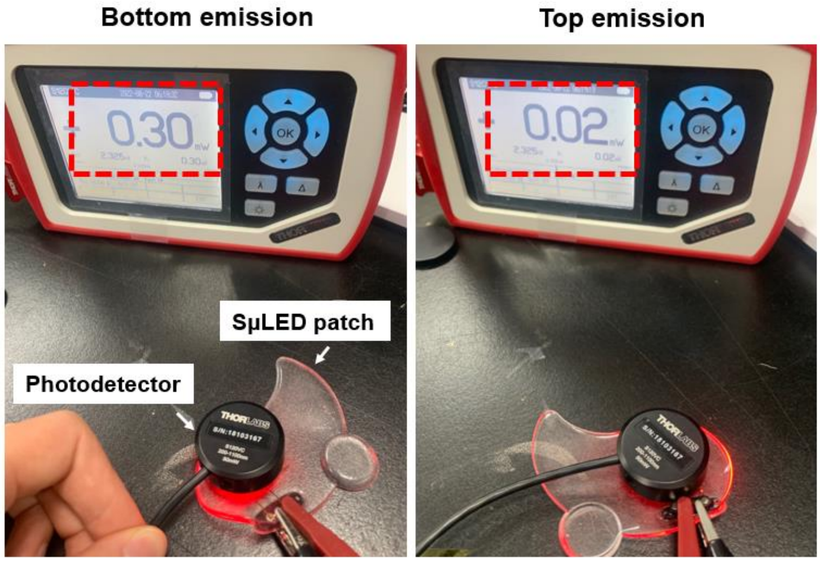

fig. S13 Light output comparison of bottom (left) and top (right) emission.

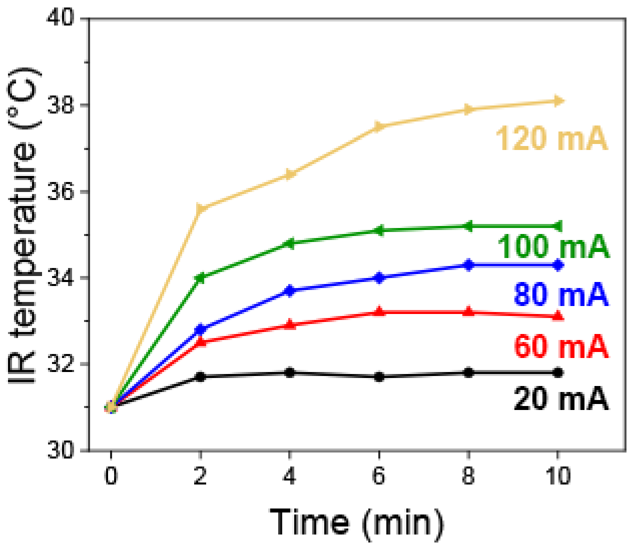

fig. S14 Temperature changes of SμLEDs on the human wrist using IR thermal radiation. The temperatures were measured after thermal equilibrium between the skin and SμLEDs.