

Supplemental Information

Amphoteric soy protein rich fibers for rapid and
selective adsorption and desorption of ionic dyes

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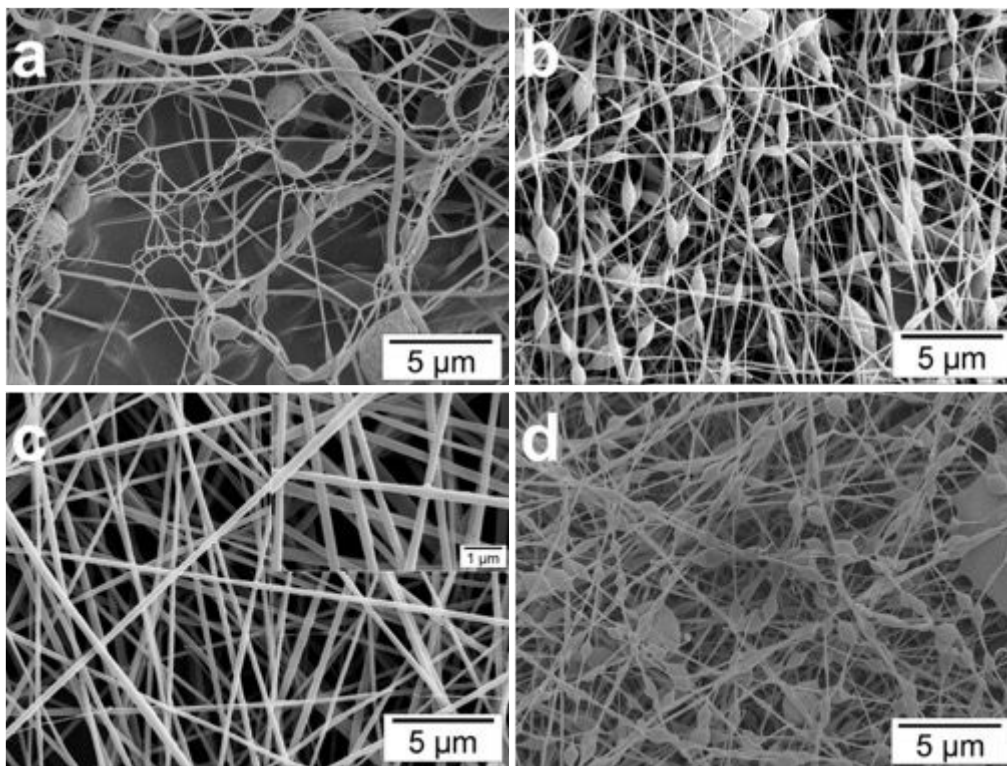


Figure S1. SEM images of electrospun products from SP/PVA mixtures (1:1, 9 %, a-c and 7:3, 9.75 %, d) with magnetically stirred SPs (1 h): (a) as is; (b) heated at 90 °C for 45 min, then pH adjusted to 12; (c-d) adjusted to pH 12 and heated at 90 °C for 45 min.

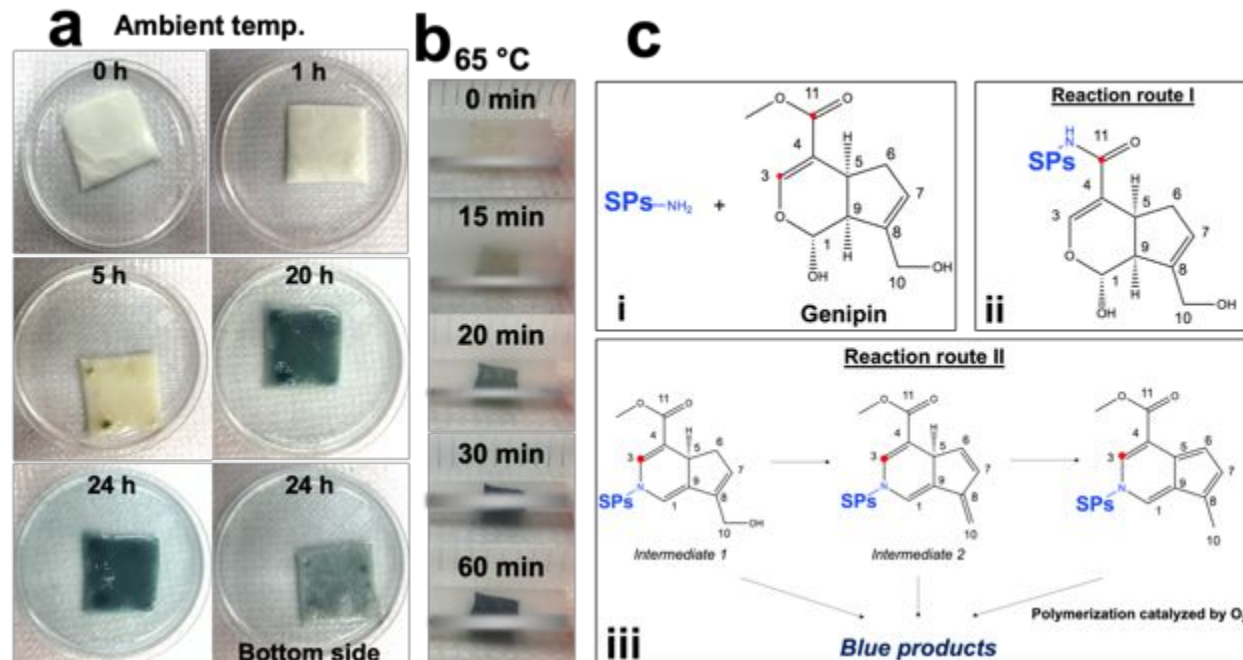
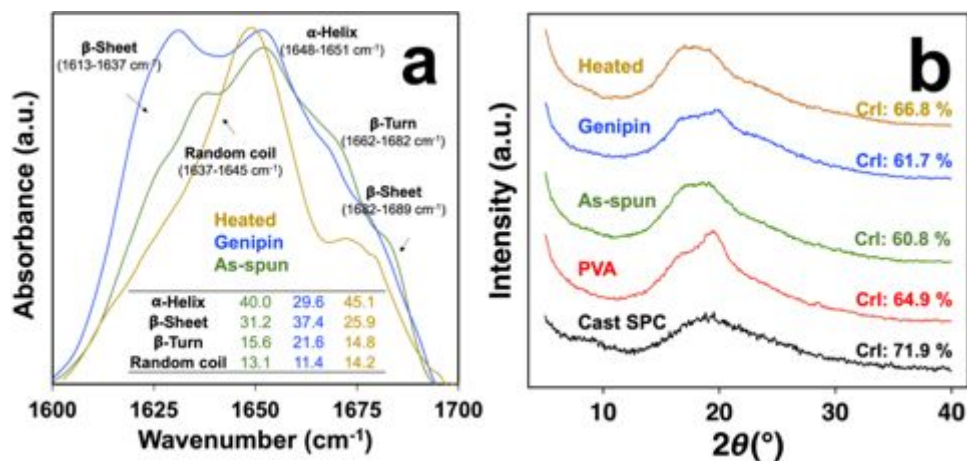


Figure S2. Appearance of electrospun SPC/PVA (7:3, 9 %) fibrous membranes: (a) submerged in genipin solutions (11 mM, in 1:1 v/v EtOH/water) at ambient temperature; (b) saturated with genipin solutions at 65 °C; (c) genipin crosslinking reaction mechanisms.



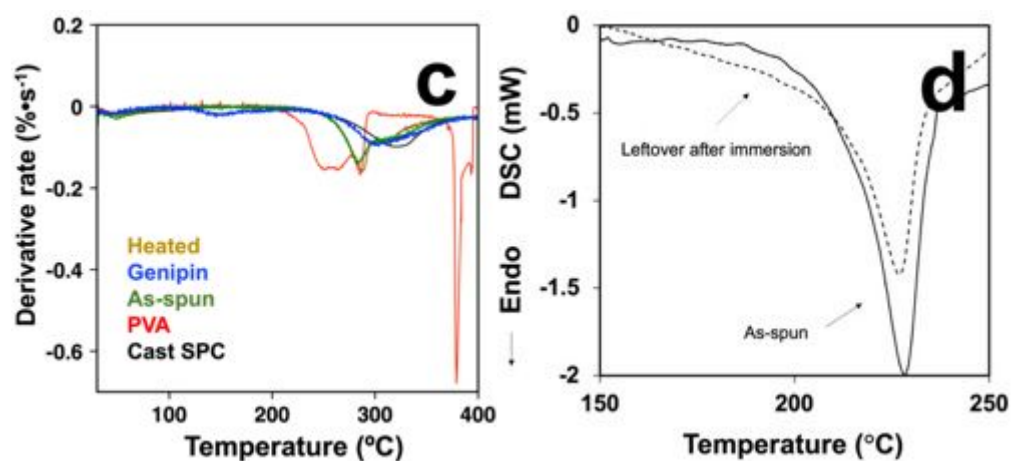


Figure S3. Characterization of SPC/PVA (7:3, 9 %) as-spun, genipin-crosslinked (65 °C, 1 h) and heated (150 °C, 12 h) fibers: (a) Amide I region by FTIR-ATR; (b) XRD patterns; (c) DTG; (d) DSC of as-spun fibers before and after immersion in water for 14 d.

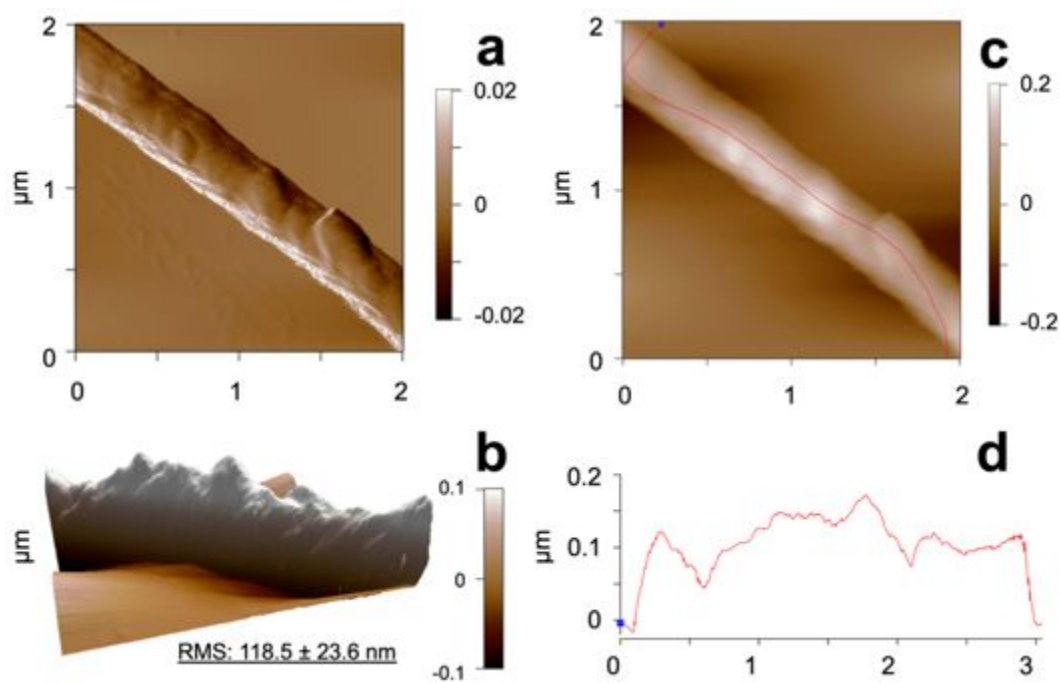


Figure S4. AFM of heat treated (150 °C, vacuum, 12 h) electrospun SPC/PVA (7:3, 9 %) fibrous membranes after being blended (30k rpm, 1 min) at 0.1 % in water: (a) amplitude; (b) 3D images; (c) height; (d) height profile.

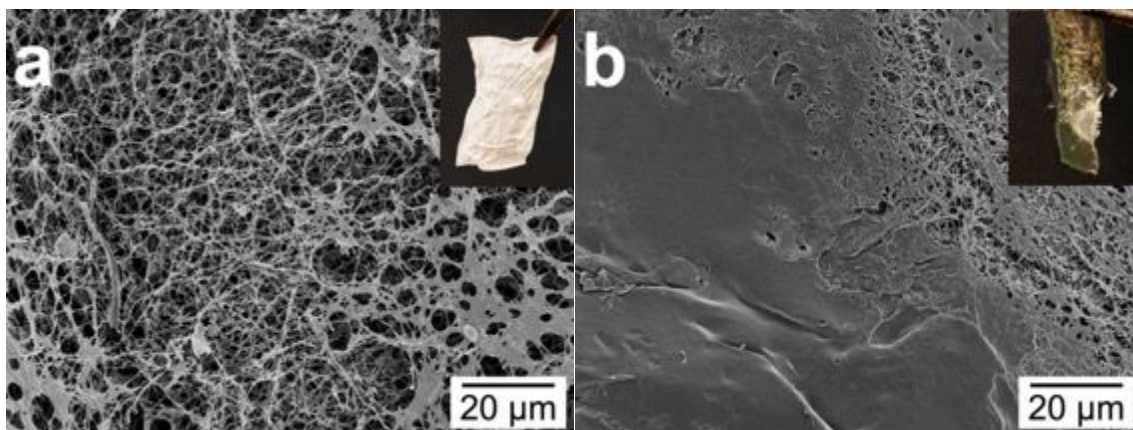


Figure S5. SEM images of as-spun electrospun SPC/PVA (7:3, 9 %) fibrous membranes immersed in water for 1 d then either: (a) freeze-dried or (b) air-dried (b). Photographic images of membranes are inserted.

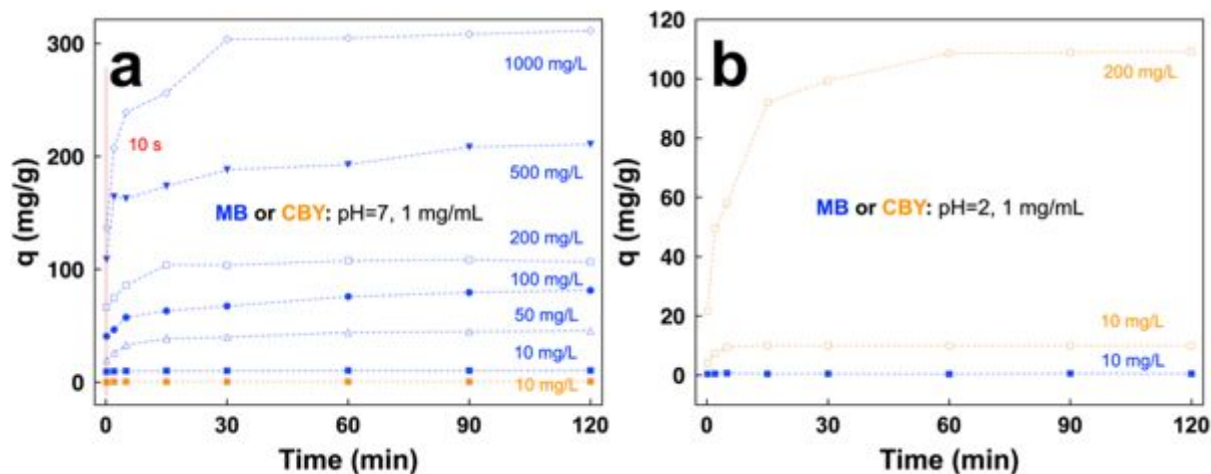


Figure S6. Dye adsorption (10-1000 mg/L) of electrospun and heat treated (150 °C, vacuum, 12 h) SPC/PVA (7:3, 9 %) fibrous membranes at 1 mg/mL membrane and aqueous dye solutions ratio: (a) MB at pH 7 ; (b) CBY at pH 2.

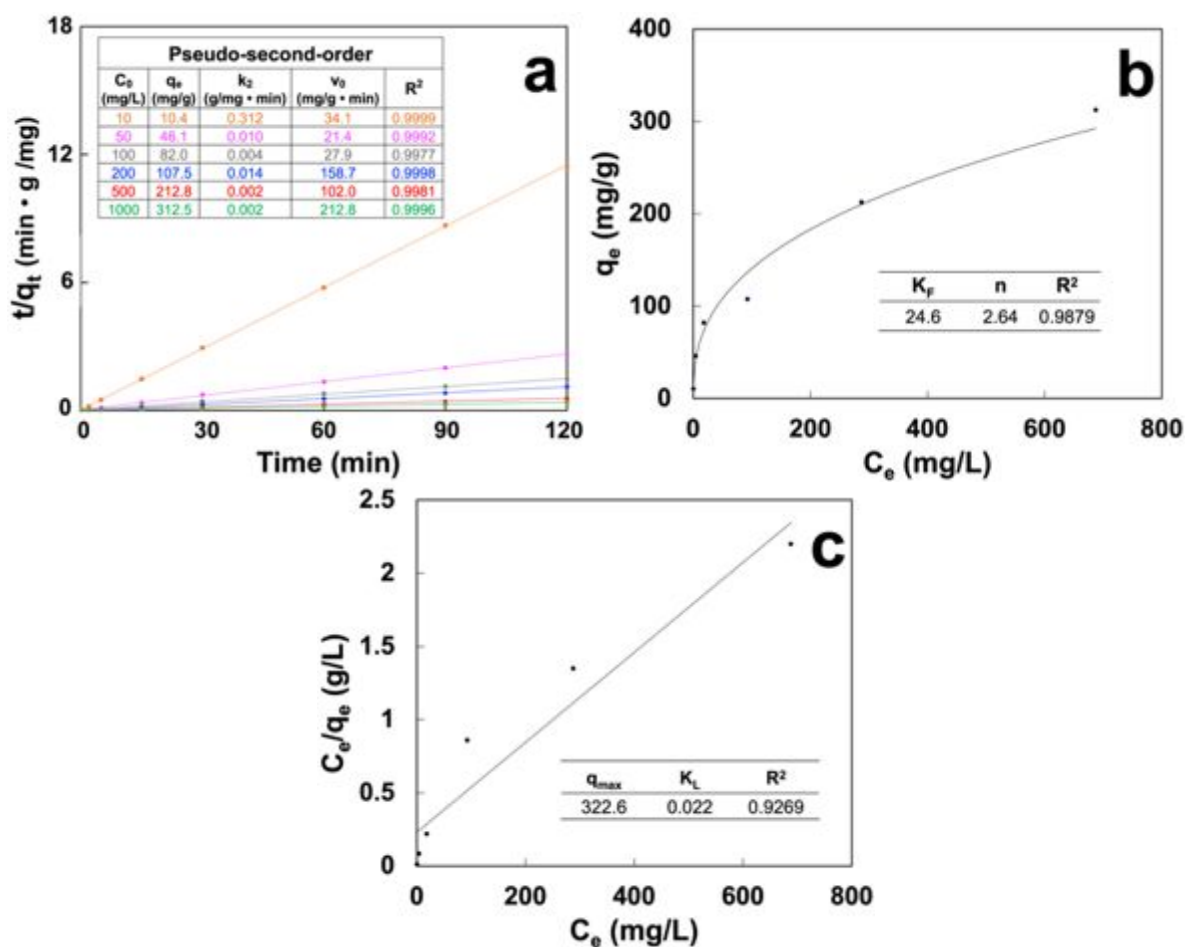


Figure S7. Adsorption of MB by electrospun and heated (150 °C, 12 h) SPC/PVA (7:3, 9 %) fibrous membranes at 1 mg/mL membrane/dye w/v ratios: (a) Pseudo-second-order adsorption kinetics; (b) Freundlich adsorption isotherm; (c) Langmuir adsorption isotherm.

Table S1. Electrospinning of SPI/PVA mixtures under different conditions and observations

SPI/PVA (w/w)	Total conc. (%)	SPI treatment	Feed rate; spinning; products
1:1	9	Magnetically stirred for 1 h	0.01 mL/h; dripping; only a few fibers with lots of beads; non-detachable.
		Magnetically stirred for 1 h, heated at 90 °C for 45 min, then pH adjusted to 12	1 mL/h; dripping; abundant beads stringing along thin fibers; non-detachable.

		Magnetically stirred for 1 h, pH adjusted to 12 and heated at 90 °C for 45 min	1.5 mL/h; continuous; ultrafine and uniform fibers with smooth surfaces, 266.8 ± 65.4 nm wide; detachable.
7:3	9.75		1 mL/h; continuous for <8 h and dripping; irregular fibers with beads, detachable.
	9	Blended for 15 min and centrifuged to take supernatants	1.5-2 mL/h; continuous; ultrafine and uniform fibers with rough surfaces, 230.9 ± 46.2 nm wide, detachable.
9:1			1 mL/h; continuous and dripping; irregular fibers with beads, detachable.

Table S2. XRD parameters of cast SPC films, as-spun and crosslinked SPC/PVA (7:3, 9 %) fibrous membranes

Cast SPC (CI=71.9 %)	2 θ (°)	9.0	18.2	22.2	26.0	30.8
	d _{hkl} (Å)	9.8	4.9	4.0	3.4	2.9
	Area (%)	2.2	33.4	20.3	10.3	5.7
ES PVA (CI=64.9 %)	2 θ (°)	N.A.	16.6	19.6	22.9	27.3
	d _{hkl} (Å)	N.A.	5.3	4.5	3.9	3.3
	Area (%)	N.A.	21.1	18.9	13.1	11.8
ES SPC/PVA (7:3): As-spun (CI=60.8 %)	2 θ (°)	N.A.	16.8	19.4	23.6	27.7
	d _{hkl} (Å)	N.A.	5.3	4.6	3.8	3.2
	Area (%)	N.A.	20.3	19.8	10.8	9.8
ES SPC/PVA (7:3): Genipin (CI=61.7 %)	2 θ (°)	N.A.	17.1	20.1	23.5	27.1
	d _{hkl} (Å)	N.A.	5.2	4.4	3.8	3.3
	Area (%)	N.A.	24.1	13.0	12.0	12.6
ES SPC/PVA (7:3): Heated (CI=66.8 %)	2 θ (°)	N.A.	17.0	19.6	23.9	28.2
	d _{hkl} (Å)	N.A.	5.2	4.5	3.7	3.2
	Area (%)	N.A.	27.3	20.7	8.3	10.6

Table S3. Thermal parameters of cast SPC films, as-spun and crosslinked SPC/PVA (7:3, 9 %) fibrous membranes

Samples	DSC		TGA		DTG
	T _m of PVA (°C)	Heat (J/g)	Moisture (%) ^a	Weight loss (%) ^b	T _{max} (°C), rate (%·s ⁻¹)
Cast SPC	NA	NA	8.2	50.4	53.9, -0.018; 317.5, -0.098
ES PVA	228.4	55.0	5.8	89.8	56.1, -0.021; 259.1, -0.151; 285.5, -0.153; 383.3, -0.338
ES SPC/PVA (7:3): As-spun	226.9	45.1	7.4	56.5	48.1, -0.029; 283.7, -0.136
ES SPC/PVA (7:3): Genipin	226.7	29.7	6.9	51.7	42.8, -0.019; 146.5, -0.023; 298.3, -0.093
ES SPC/PVA (7:3): Heated	215.7	16.3	5.3	55.8	42.0, -0.021; 287.4, -0.158; 313.3, -0.089

^a Up to 150 °C

^b 210-400 °C

Table S4. Mass loss of as-spun and crosslinked electrospun SPC/PVA (7:3, 9 %) fibrous membranes after immersion in water (average ± standard deviation, N=3)

Immersion time (d)	As-spun (%)	Genipin (%)	Heated (%)
1	36.9 ± 4.3	10.8 ± 2.1	3.3 ± 2.4
14	38.3 ± 3.3	21.5 ± 3.1	5.6 ± 2.9

Table S5. Color coordinates of as-spun and crosslinked electrospun SPC/PVA (7:3, 9 %) fibrous membranes

Standard	L*	a*	b*
(As-spun)	96.00	-0.35	2.43
Samples	ΔL^*	Δa^*	Δb^*
As-spun: wet	-47.72 D	-1.07 G	-3.85 B
Genipin: FD	-20.19 D	-4.83 G	-3.08 B
Genipin: wet	-52.87 D	-5.74 G	-4.66 B
Genipin: AD	-52.00 D	-2.14 G	-4.64 B
Heated: as was	-8.89 D	1.52 R	11.35 Y
Heated: wet	-34.40 D	0.89 R	21.33 Y
Heated: AD	-10.65 D	2.35 R	16.23 Y

ΔL^* indicates darkness or lightness of the shade. If ΔL^* value is positive (+) then the shade is lighter. If ΔL^* value is negative, then the shade is darker.

Δa^* value indicates radish of the shade. If the Δa^* value is positive (+) then the shade is more red. If the Δa^* value is negative, then the shade is less red.

Δb^* value indicates yellowness of the shade. If Δb^* value is positive (+) then the shade is more yellow. If the Δb^* value is negative, then the shade is less yellow.