Electronic Supplementary Information

Natural Polymer-Based Bioabsorbable Conducting Wires for Implantable Bioelectronic Devices

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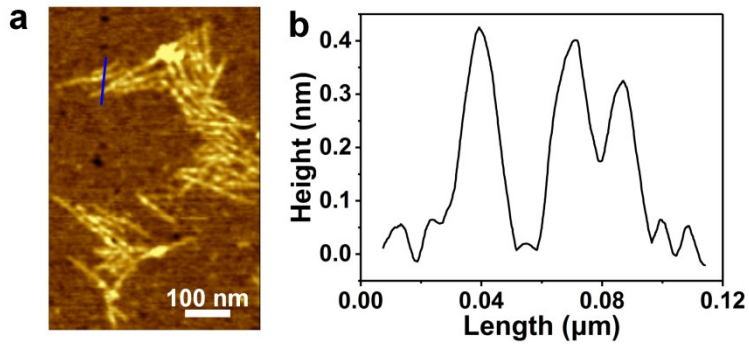

Fig. S1 (a) AFM image and (b) height profile of SNRs derived from TEMPO/NaBr/NaClO solvent system containing 0.016 mol NaClO, 0.02 g TEMPO, and 0.1 g NaBr per gram of DS. The blue line in (a) was used to measure the (b) height of three SNRs.

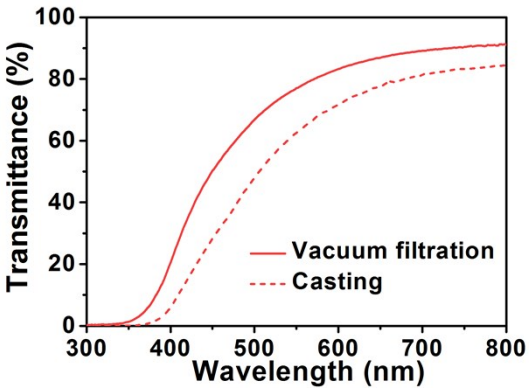

Fig. S2 Comparison of UV-*vis* transmittance of S8K2 with a thickness of 45 μm prepared by casting and vacuum-filtration methods.

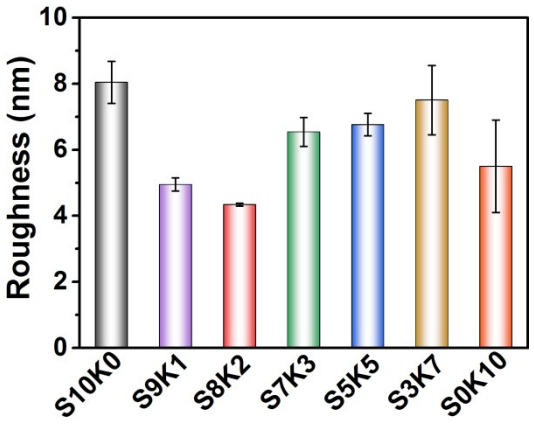

Fig. S3 Surface roughness of SKCFs with different mass ratios.

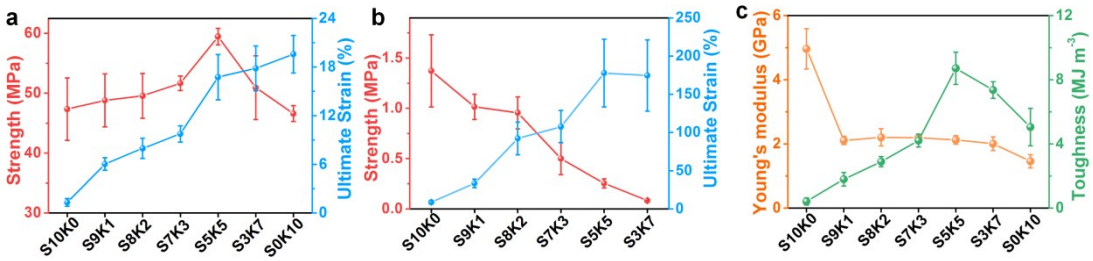

Fig. S4 Strength and elongation at break of SKCFs in (a) dry and (b) wet conditions. (c) Effect of SKCF mass ratios on Young's modulus and toughness of SKCFs in dry conditions.

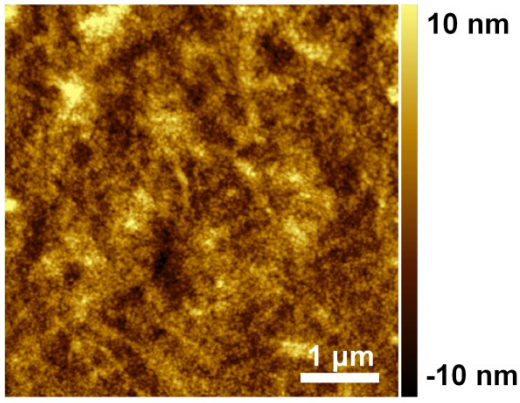

Fig. S5 AFM image of the surface morphology of SKCF-Au wire.

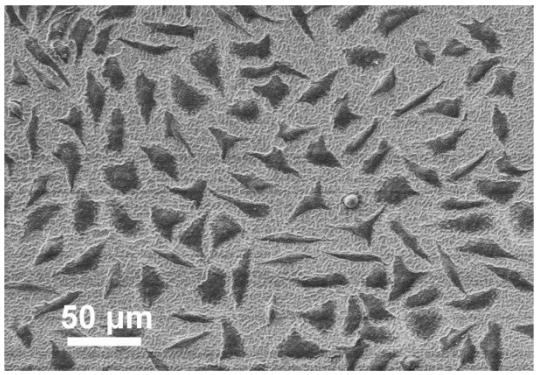

Fig. S6 Representative scanning electron micrograph of L929 cells seeded on SKCF-Au film for 3 d.

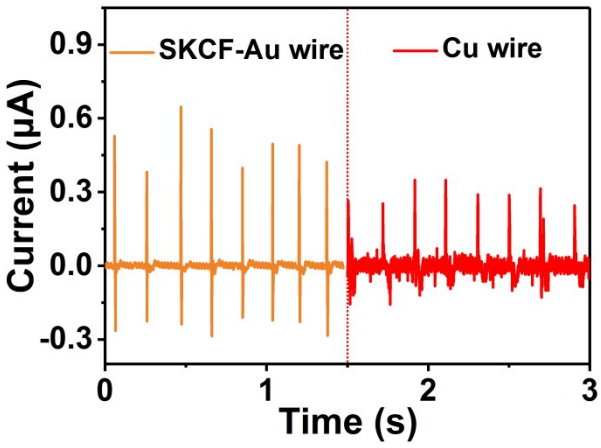

Fig. S7 Output current of TENG using two kinds of conducting wire at a frequency of 4 Hz.

Table S1 Comparison of the PD of the integrated energy generated device with that of other previously reported bio-based TENGs.

Materials				PD (mW/m^2)	Biodegrad-able TENG	Conducting wire	Biodegra-dable	Ref.
Friction layer type	Friction layer	Conducting layer	Encapsula-tion layer					
NP/SP	Chitosan/Kapton	Al	---	0.0175	No	Copper electrode	No	[1]
	CNF/FEP	ITO	PET	5600	No	Copper tapes	No	[2]
	PVA/SA	Al/Li	Soluble tape	3.8	Yes	Conductive tape	No	[3]
	RSSP/PET	ITO	---	1030	No	Metal wire	No	[4]
	RSSP/PET& PVDF	ITO/Cu	---	4016	No	Metal wire	No	[5]
	Leaf/PMMA	Metal	---	45	No	Metal electrode	No	[6]
SF/SP	RSFF/PET	ITO	---	68	No	Metal wire	No	[7]
	ESM/PI	Al	---	4.3	No	Metal wire	No	[8]
	RSFF/PET	ITO	---	1936	No	Metal wire	No	[9]
	ESM/PVA& MXene	Al	---	1087.6	No	Metal wire	No	[10]
	ESM/PCL& GO	Au	PCL	72	Yes	Metal wire	No	[11]
	ESM/PVDF	Conductive fabric	---	3100	No	Metal wire	No	[12]
	RSFF/PTFE	Al	Acrylic substrate	22050	No	Metal wire	No	[13]
	Silk aerogel/PTFE	ITO	PET	370	No	Aluminum strand	No	[14]
	RSFF/PET	ITO	Plastic casing	371.8	No	Metal wire	No	[15]
NP/NP	CCP/NCM	Copper foil	Print paper	16100	No	Metal wire	No	[16]
	Calcium Alginate	Al	PLA	10.6	No	Metal wire	No	[17]
	Nitro-CNF/Methyl-CNF	ITO	PET	640	No	Metal wire	No	[18]
	BNC	Copper foil	PPF&POM	4.8	No	Metal wire	No	[19]
	Starch	Water film	---	2.58	Yes	Metallic wire	No	[20]
	Leaf/Liquid	Cr/Au	---	0.0024	Yes	Metal wire	No	[21]
SF/NP	RSFF	Mg	RSFF	38.5	Yes	Metal lead wire	No	[22]
	RSFF/Rice	Mg	RSFF	21.6	Yes	Metal lead	No	[23]

	paper					wire		
	SNRF/ESM	Mg/Al	RSFF	102	No	Cu wire	No	[24]
	SNRF/RSFF	Mg	RSFF	86.7	Yes	Cu wire	No	[24]
	SNRF/RSFF	Mg	RSFF	314.4	Yes	SKCF-Au wire	Yes	This work

Note: CNF (cellulose nanofibril), FEP (fluorinated ethylene propylene), PET (poly(ethyleneterephthalate)), PVA (polyvinyl alcohol), SA (alginate sodium), RSSP (recombinant spider silk proteins), PVDF (Poly(vinylidene fluoride)), PMMA (poly(methyl methacrylate)), ESM (electrospinning mat), PI (polyimide), RSFF (regenerated silk fibroin film), PCL (polycaprolactone), PTFE (polytetrafluoroethylene), ITO (indium tin oxide), CCP (crepe cellulose paper), NCM (nitrocellulose membrane), BNC (bacterial nanocellulose), PPF (polypropylene), POM (polyoxymethylene), PLA (polylactic acid), SNRF (silk nanoribbon film).

Table S2 Comparison of the conducting wires.

Type	Conductive material	Conductive material content	Other materials	Conductive property	Biodeg-radability/working time	Ref.
Conventional metallic wire	Cu	100%	No	Resistivity 1.75 $\times 10^{-8}$ Ω·m	No	---
	Al	100%	No	Resistivity 2.83 $\times 10^{-8}$ Ω·m	No	---
Fiber-shaped wire	Cu-CNT	100%	No	Resistivity 1.6 $\times 10^{-7}$ Ω·m	No	[25]
	CNT-Au-Cu	100%	No	Conductivity 4.65×10^{5} S/cm	No	[26]
	Aligned CNT	T=0.15-1.59 μm	self-healing polymer	Resistance 140 Ω/cm	No	[27]
	CNT	---	self-healing polymer	Resistance 5.7×10^{3} Ω/cm	No	[27]
	Ag nanowire	---	self-healing polymer	Resistance 12 Ω/cm	No	[27]
	Ag-Au naowire	---	SBS elastomer	Conductivity 4.2×10^{4} S/cm	No	[28]
	Silver nanowire	30 μm	PET fibers	Resistivity 1.62×10^{-8} Ω·m	No	[29]
Biodegradable metals	Mg, Mg-Ca, Mg-Zn, Mg-Si, Mg-Sn, Mg-Zr, Mg-Al,	100%	No	---	Yes	[30-32]
	Fe, Fe-Mn,	100%	No	---	Yes	[32]
	Zn, Ca, Sr	100%	No	---	Yes	[32]
Biodegradable wire	Mg	T=7.5 μm	poly(DTE carbonate), and PCL	Resistance 1 Ω/cm	Yes/7 d	[33]
	PEDOT:PSS	D=48 μm	RSF	Conductivity 138 S/cm	Yes/7 d	[34]
	Cr/Au	T=150 nm	SKCF	Resistance 8 Ω/cm	Yes/10 d	This work

Note: CNT (carbon nanotube), PET (poly(ethyleneterephthalate)), PCL (polycaprolactone), RSF (regenerated silk fibroin), SBS (poly(styrene-butadiene-styrene)), PET (poly(ethyleneterephthalate)), PEDOT:PSS (poly(3,4-ethylenedioxythiophene) : poly(styrenesulfonate)), poly(DTE carbonate) (poly(desamino tyrosyl-tyrosine ethyl ester carbonate)), RSF (regenerated silk fibroin). "T"=thickness, "D"=diameter.

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