Electronic Supplementary Information

Electrospun Bio-Zein Conductive Composites Engineered with Versatile Nanomaterials for High-Performance Supercapacitors

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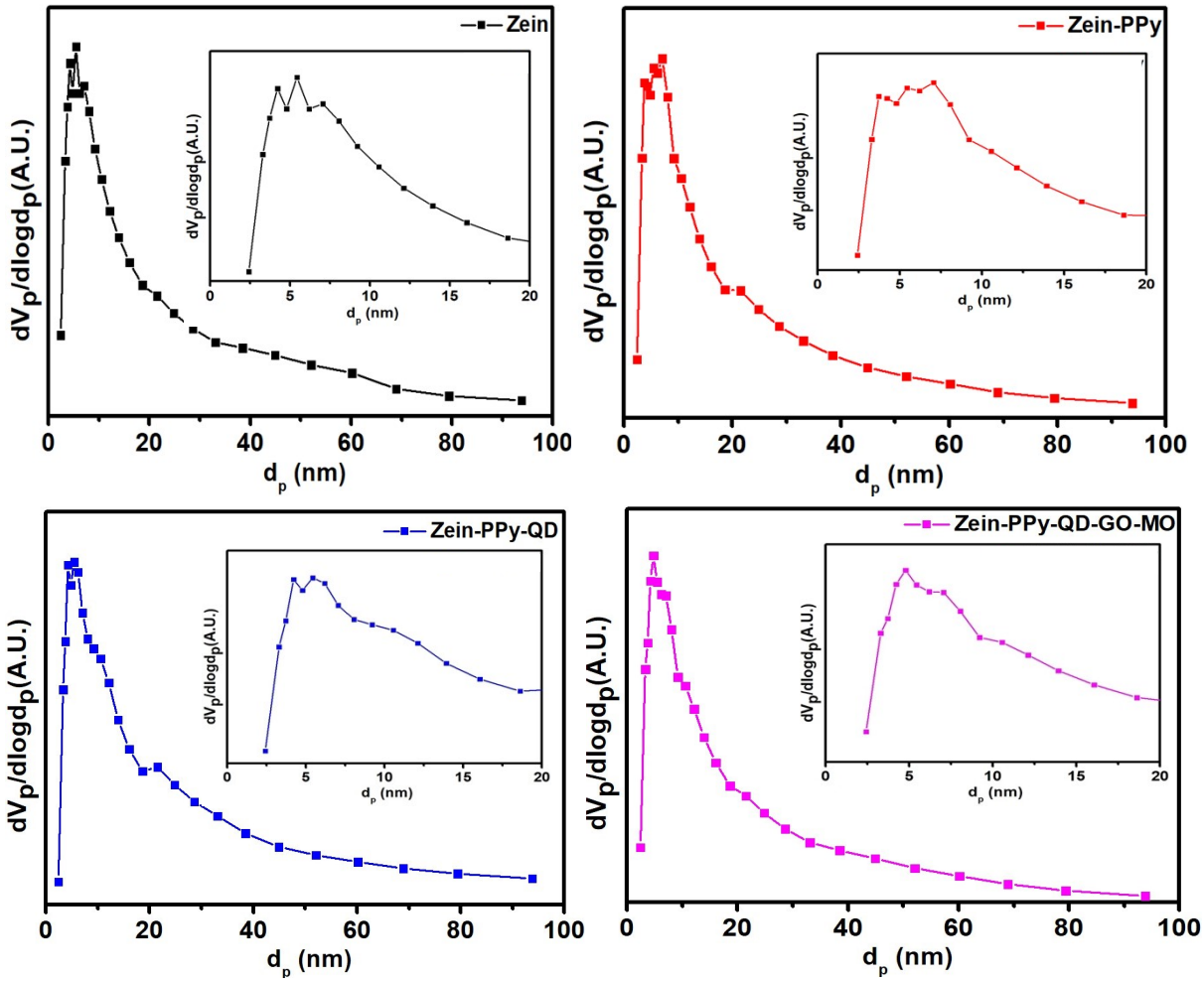

Fig. S1: N_2 adsorption–desorption isotherms and corresponding pore size distributions of the zein-based composites.

Table. S1: BET surface areas and average pore diameters for each functionalization stage.

Sample	S_{BET} (m^2/g)	V_{total} (cm^3/g)	V_{meso} (cm^3/g)	V_{micro} (cm^3/g)	Pore size (nm)
Zein	2.83000	0.01700	0.00719	0.00981	5.43
Zein-PPy	0.30693	0.01001	0.00475	0.00535	7.05
Zein-PPy-QD	0.00396	0.00433	0.00214	0.00219	5.43
Zein-PPy-QD-GO-MO	0.63264	0.00528	0.00248	0.00280	4.78

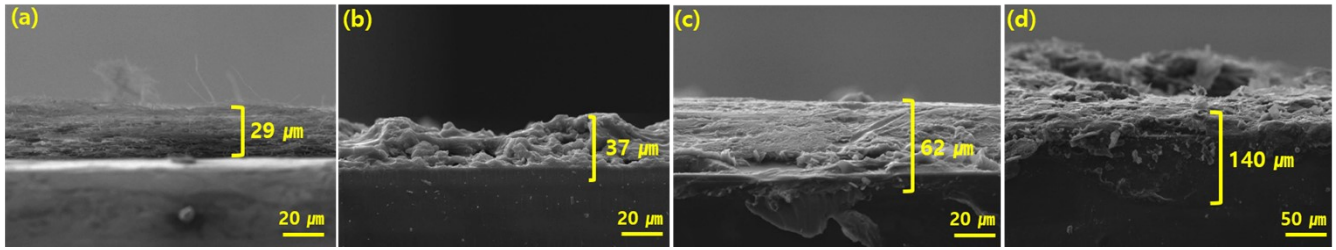

Fig. S2: Cross-sectional SEM images of electrospun electrodes:
pristine zein (a), zein-PPy (b), zein-PPy-QD (c), all at 1 000× magnification, and zein-PPy-QD-GO-MO (d) at 500× magnification.

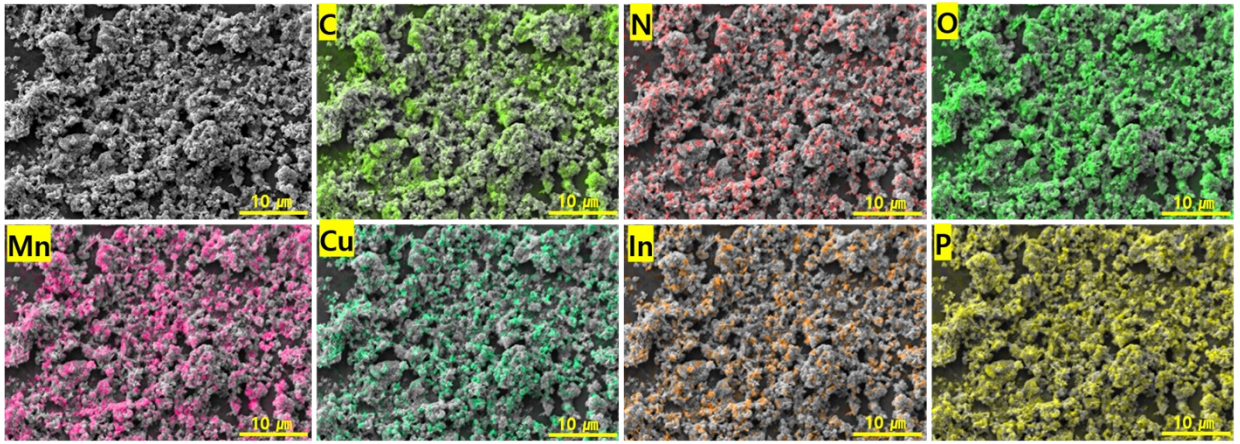

Fig. S3: EDS mapping of the analysis zein-PPy-QD-GO-MO composite.

Table. S2: Sheet resistance, layer thickness, and conductivity of zein-based composites

	Sheet resistance (Ω/□)	Thickness of the layer (μm)	Conductivity (S/cm)
Zein-PPy	1.5×10^{7}	37	1.80×10^{-5}
Zein-PPy-QD	2.9×10^{6}	62	5.56×10^{-5}
Zein-PPy-QD-GO-MO	4.9×10^{5}	140	1.44×10^{-4}

$$\sigma = \frac{1}{R_s\, t} \qquad \text{..... (Eq. S1)}$$

Eq. S1: Equation of conductivity calcualtion:

where σ is the electrical conductivity (S cm^{-1}), R_s is the sheet resistance (Ω $□^{-1}$), and t is the thickness of the layer (cm).

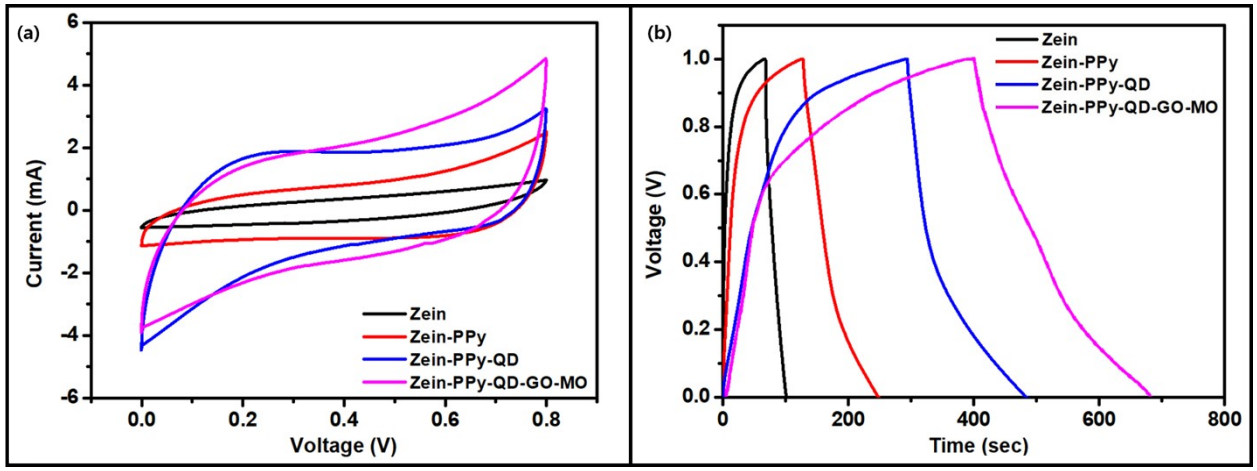

Fig. S4: CV (a) and GCD (b) of electrospun zein-based material composites at 250 mV/s and 0.25 mA scan rate.

Table. S3: Electrochemical performance comparison of our electrospun zein-based composite and representative bio-derived nanofiber scaffolds

Scaffold (Matrix)	Active Materials	Electrolyte	Current density	Capacitance	Cycle number	Capacitnace Retention	coulombic efficiency	Energy density	Power density	Ref no.
Electrospun Zein	PPy, InP QD, GO, CuO/MnO_2	6.0 M KOH	0.25 mA cm^{-2}	135.00 mF cm^{-2}	6,000	70.0%	Approximately 100.0%	18.75 μWh cm^{-2}	20,000.00 mW cm^{-2}	Our work
Glucose/Type A gelatin	PPy	0.2 M LiTFSI	0.05 mA	175.00 F g^{-1}		not described	not described	1519.10 μWh g^{-1}	0.34 mW g^{-1}	73
cellulose film	PPy, f-CNT	1.0 M H_2SO_4	1.00 mA cm^{-2}	2147.00 mF cm^{-2}	10,000	104.6	not described	190.80 μWh cm^{-2}	0.43 mW cm^{-2}	74
cellulose tissue	Graphene	1.0 M H_2SO_4	0.50 A cm^{-2}	80.00 mF cm^{-2}	5,000	95.0%	99.1%	9.00 μWh cm^{-2}	100.00 mW cm^{-2}	75
cellulose nanofiber ink	GO	1.0 M KOH	1.00 mA cm^{-2}	98.61 mF cm^{-2}		not described	not described	8.59 μWh cm^{-2}	0.41 mW cm^{-2}	76
Cellulose Film	CNT,MnO2	1.0 M Na_2SO_4	1.00 mA cm^{-2}	7956.00 mF cm^{-2}	10,000	79.0%	not described	251.66 μW h cm^{-2}	24.85 mW cm^{-2}	77
cellulose nanofiber	GO,PPy	1.0 M H_2SO_4	0.10 mA cm^{-2}	647.00 mF cm^{-2}	10,000	92.5%	92.6%	14.37 μWh cm^{-2}	0.02 mW cm^{-2}	78
Lignin containing cellulose nanofibrill	PPy	PVA-H_2SO_4	1.00 mA cm^{-2}	2567.00 mF cm^{-2}	2,000	75.1%	98.0%	88.60 μWh cm^{-2}	0.50 mW cm^{-2}	79
Lignin-based hydrogel	PPy, GO, ZnO	Py/$NaClO_4$	1.00 A g^{-1}	175.00 F g^{-1}	1,000	72.3%	not described	11,909.70 μWh g^{-1}	0.80 mW g^{-1}	80
electrospun lignin based carbon/graphene fiver	lignin-derived carbon/graphene	PVA/H_2SO_4	0.10 mA cm^{-2}	206.48 mF cm^{-2}	7,000	98.0%	not described	5.79 μW h cm^{-2}	20.02 mW cm^{-2}	81
chitosan	GO/PPy	PVA/H_2SO_4	1.00 mA cm^{-2}	72.79 mF cm^{-2}	10,000	88.0%	not described	6.50 μWhcm^{-2}	1.33 mW cm^{-2}	82
chitosan	GO,MnO2	1.0 M Na_2SO_4	5.00 mA cm^{-2}	3553.74 mF cm^{-2}	10,000	74.1%	99.1%	0.59 mWh cm^{-2}	3000.00 mW cm^{-2}	83