

1. Experimental Section

(1) Fabrication of LS-TENG Test Tubes

A wire was inserted into the surface of a nickel-plated polyurethane foam (Shenzhen Zhuoyue Light Plastic Products Co., Ltd.) and the foam was then pressed into a prepared narrow tube, positioning the top surface of the conductive foam 4 cm below the tube opening. The wire was secured in place, forming a functional test tube for detection experiments.

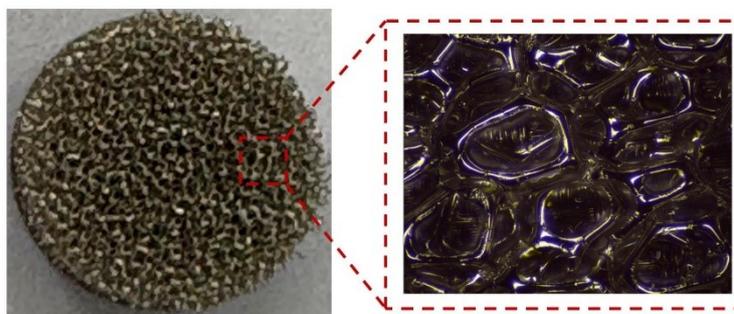


Figure S1. Schematic diagram and microstructure of the nickel-plated polyurethane foam sponge.

2. Data Collection and Analysis

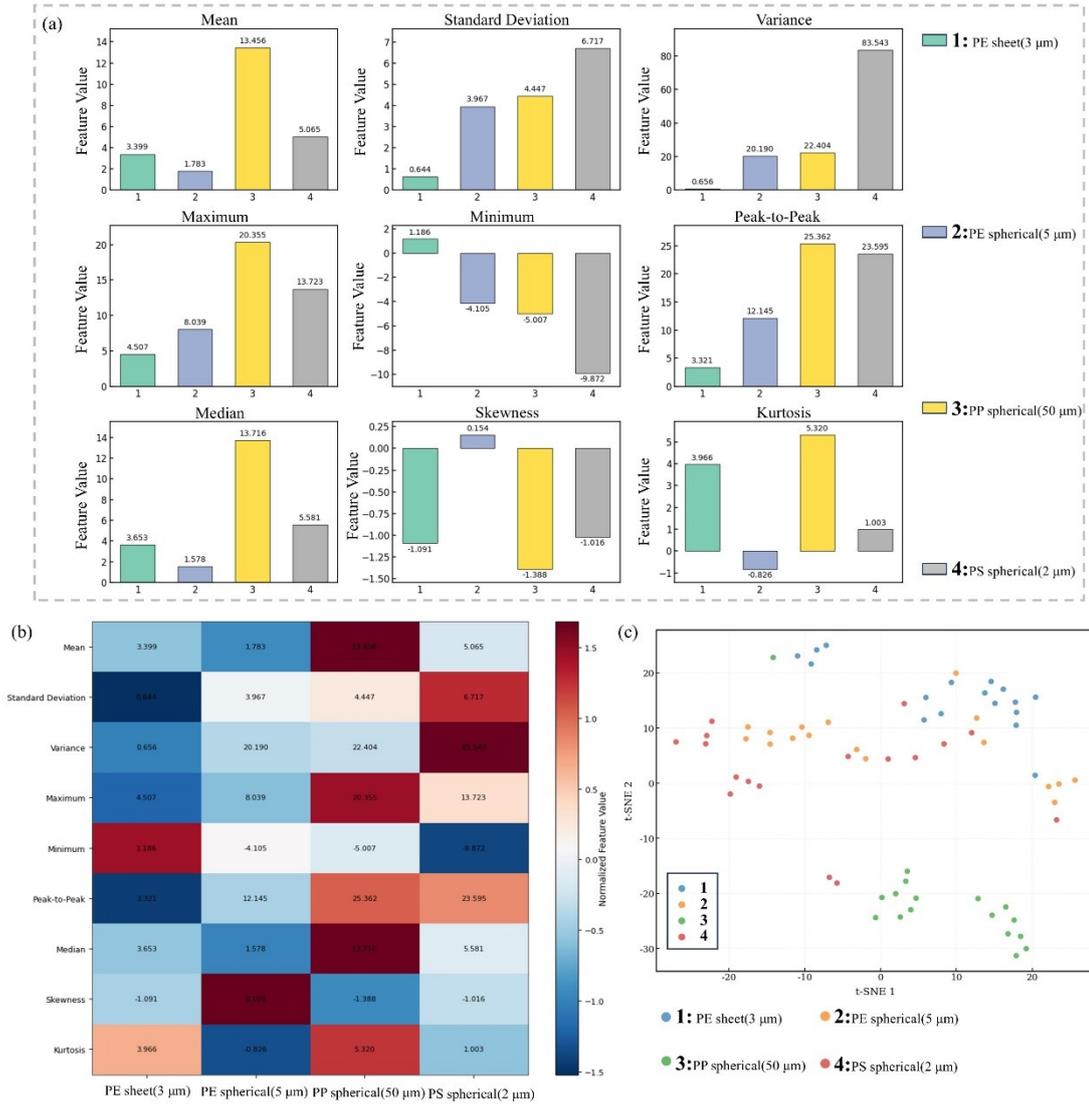


Figure S2. Analysis of Triboelectric Signals from Microplastic Mixtures: (a) Average Statistical Characteristics; (b) Heat Map of Voltage Signal Statistical Features; (c) Dimensionality Reduction Visualization of Voltage Signal Characteristics

Table S1. Hyperparameters of the Random Forest Model

Module/parameter Name	Hyperparameters
n-estimators	300
Max depth	7
Min-samples-split	2
Min-samples-leaf	2
Max-features	log2

3. Identification results of MPs

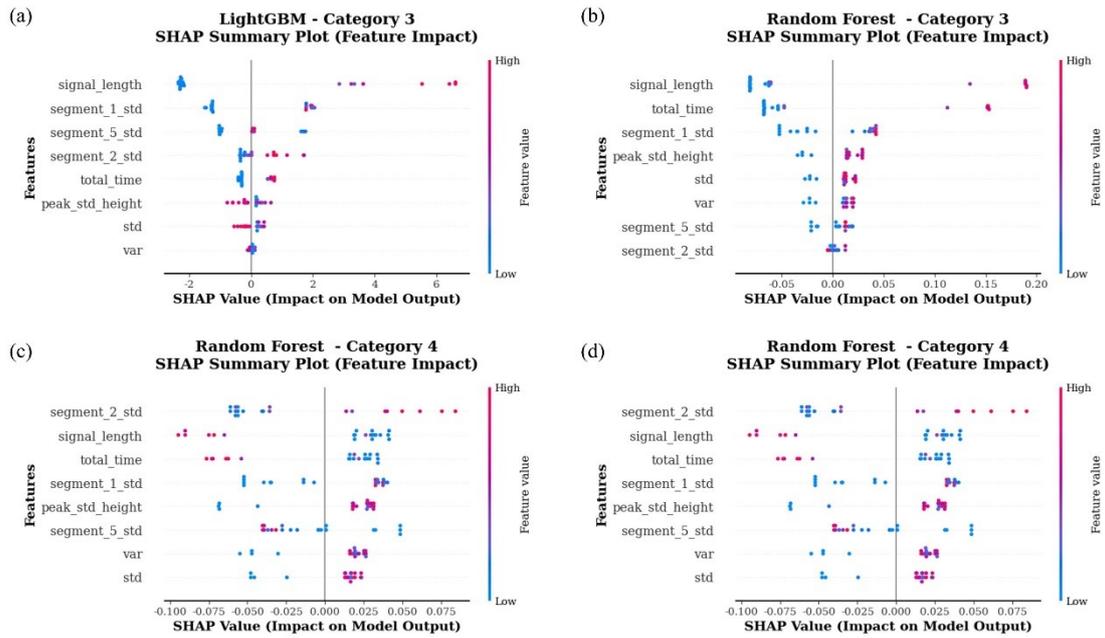


Figure S3. Model Outputs for Different Microplastic Types: (a) PP Spherical 50 μm (LightGBM); (b) PP Spherical 50 μm (RF); (c) PS Spherical 2 μm (LightGBM); (d) PS Spherical 2 μm (RF)

3. Data Set of MPs

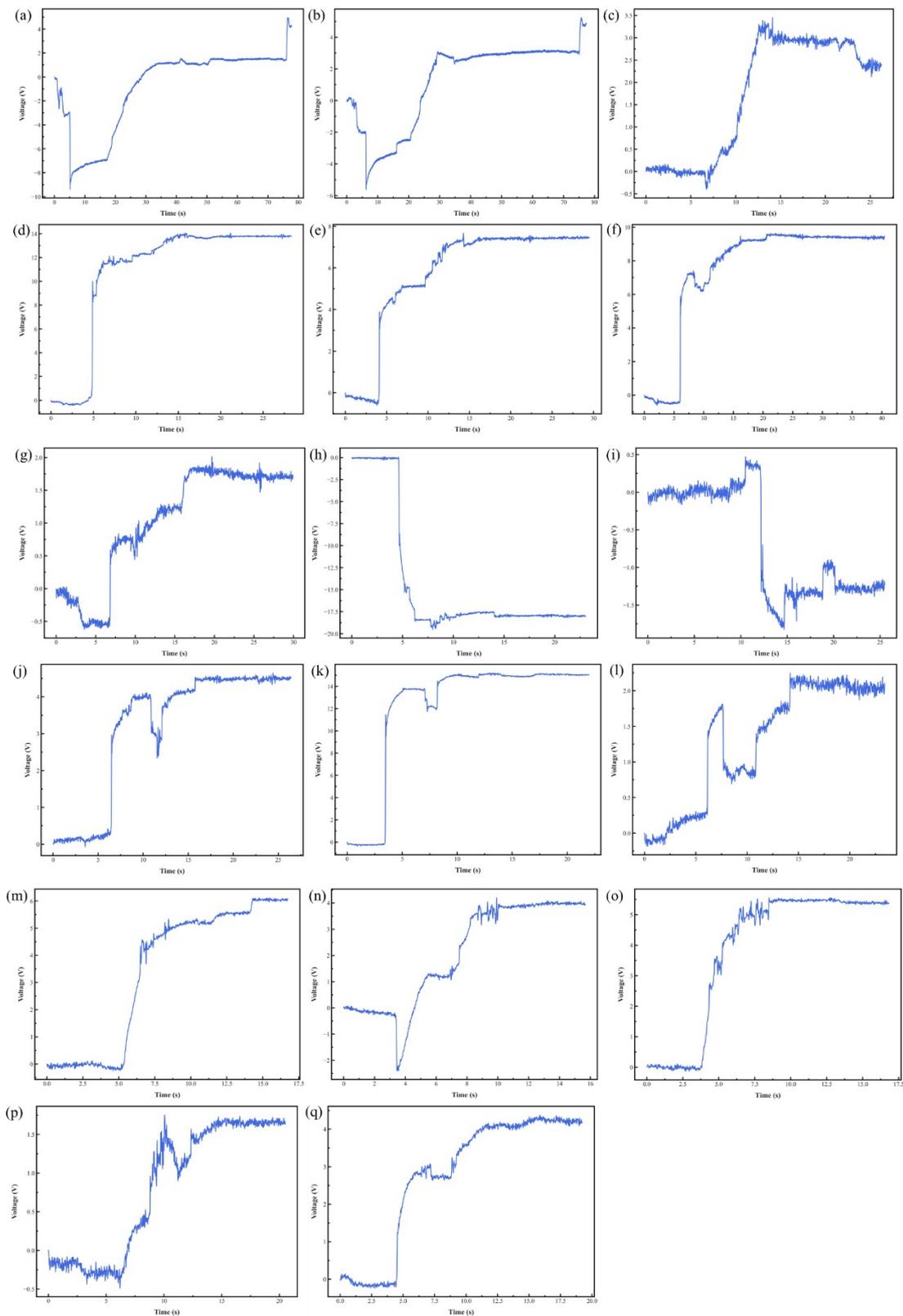


Figure S4. PE Sheet $3\mu\text{m}$: (a) $C=0.1 \times 10^{-5}$ g/mL; (b) 0.2×10^{-5} g/mL; (c) 0.3×10^{-5} g/mL; (d) 0.4×10^{-5} g/mL; (e) 0.5×10^{-5} g/mL; (f) 0.6×10^{-5} g/mL; (g) 0.7×10^{-5} g/mL; (h) 0.8×10^{-5} g/mL; (i) 0.9×10^{-5} g/mL; (j) 1.0×10^{-5} g/mL; (k) 1.1×10^{-5} g/mL; (l) 1.2×10^{-5} g/mL; (m) 1.3×10^{-5} g/mL; (n) 1.4×10^{-5} g/mL; (o) 1.5×10^{-5} g/mL; (p) : 1.6×10^{-5} g/mL; (q) : 1.7×10^{-5} g/mL

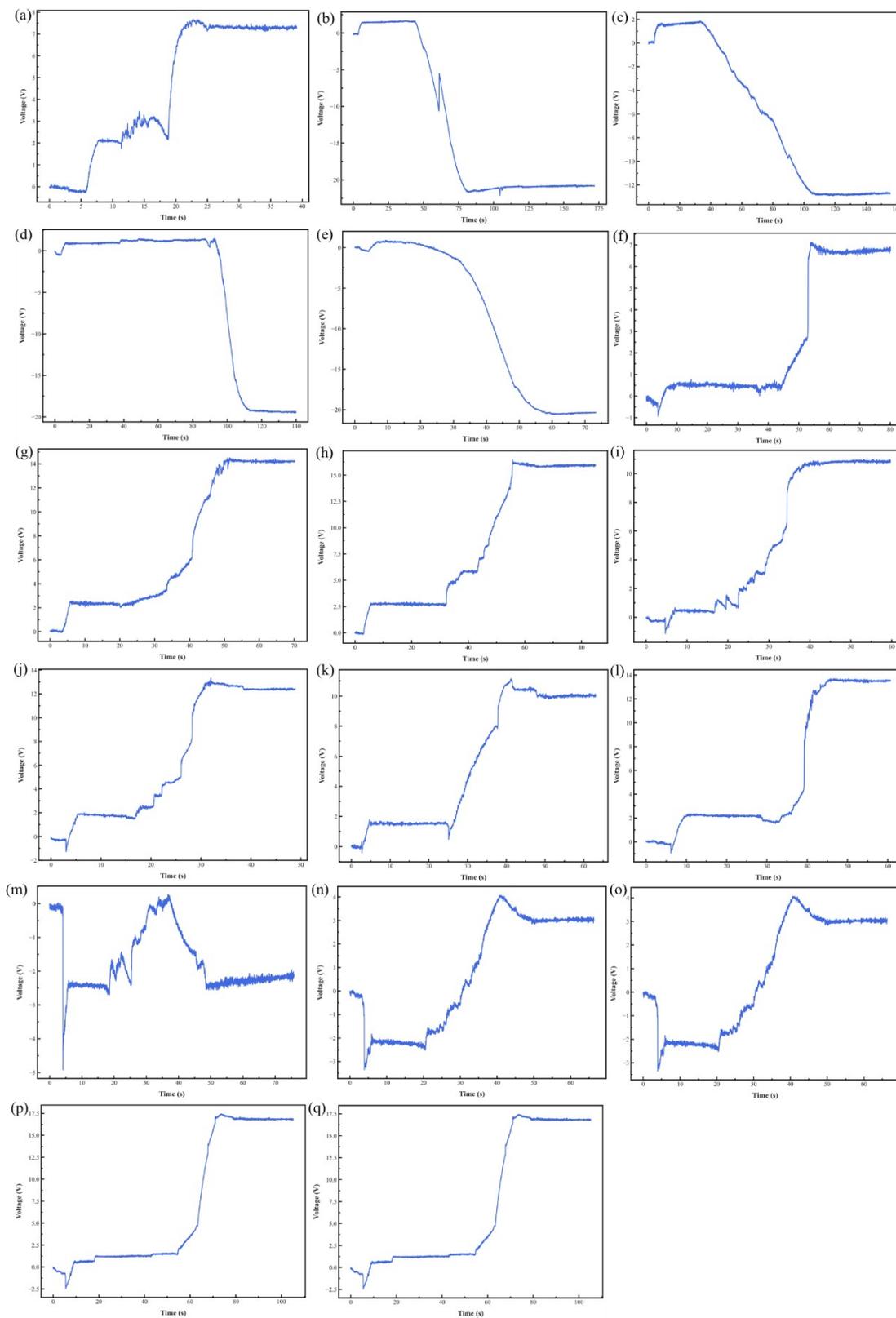


Figure S5. PE Spherical 5 μm : (a) $C=0.1 \times 10^{-5}$ g/mL; (b) 0.2×10^{-5} g/mL; (c) 0.3×10^{-5} g/mL; (d) 0.4×10^{-5} g/mL; (e) 0.5×10^{-5} g/mL; (f) 0.6×10^{-5} g/mL; (g) 0.7×10^{-5} g/mL; (h) 0.8×10^{-5} g/mL; (i) 0.9×10^{-5} g/mL; (j) 1.0×10^{-5} g/mL; (k) 1.1×10^{-5} g/mL; (l) 1.2×10^{-5} g/mL; (m) 1.3×10^{-5} g/mL; (n) 1.4×10^{-5} g/mL; (o) 1.5×10^{-5} g/mL; (p) 1.6×10^{-5} g/mL; (q) 1.7×10^{-5} g/mL

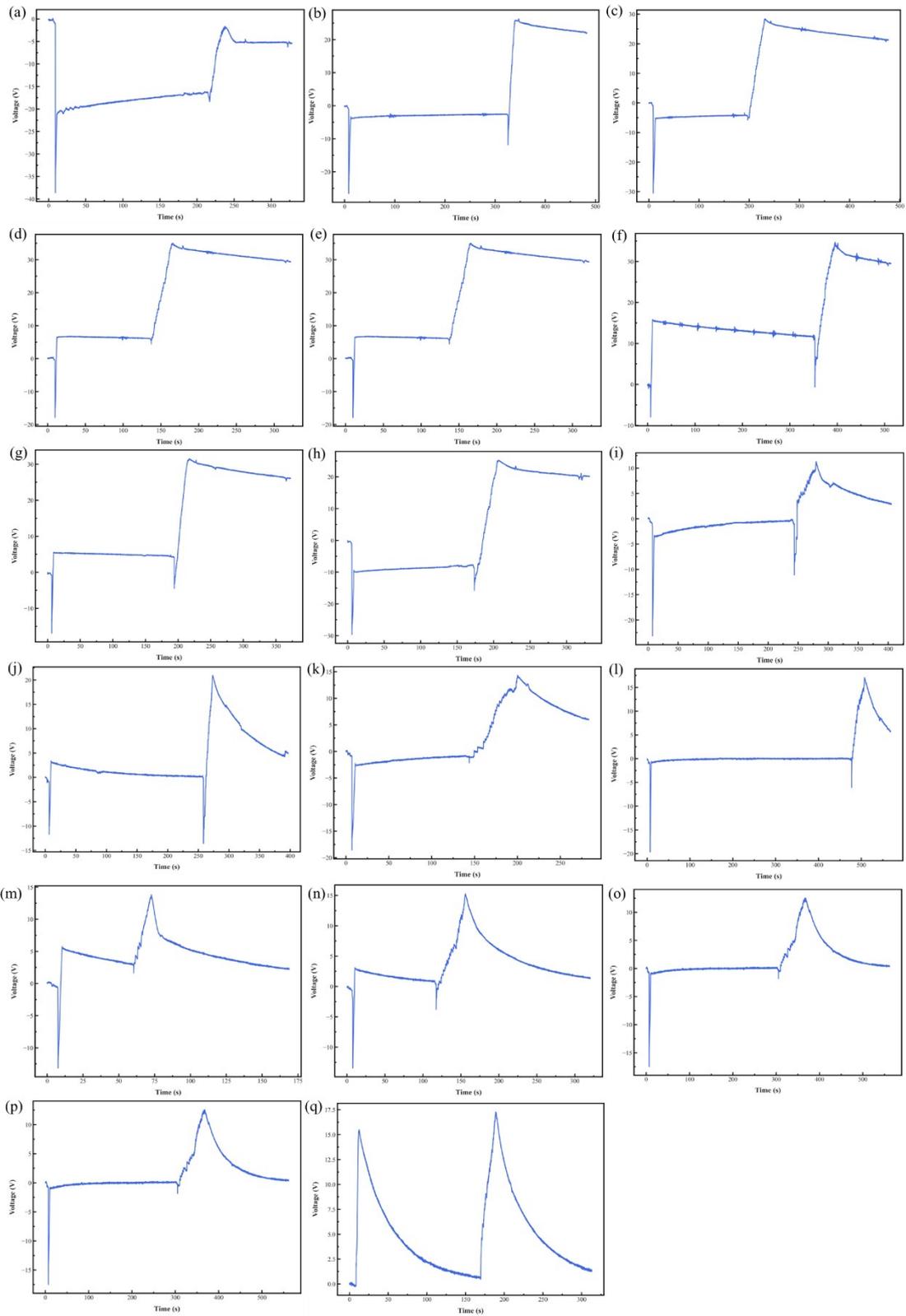


Figure S6. PP Spherical 50 μm : (a) $C=0.1 \times 10^{-5}$ g/mL; (b) 0.2×10^{-5} g/mL; (c) 0.3×10^{-5} g/mL; (d) 0.4×10^{-5} g/mL; (e) 0.5×10^{-5} g/mL; (f) 0.6×10^{-5} g/mL; (g) 0.7×10^{-5} g/mL; (h) 0.8×10^{-5} g/mL; (i) 0.9×10^{-5} g/mL; (j) 1.0×10^{-5} g/mL; (k) 1.1×10^{-5} g/mL; (l) 1.2×10^{-5} g/mL; (m) 1.3×10^{-5} g/mL; (n) 1.4×10^{-5} g/mL; (o) 1.5×10^{-5} g/mL; (p) 1.6×10^{-5} g/mL; (q) 1.7×10^{-5} g/mL

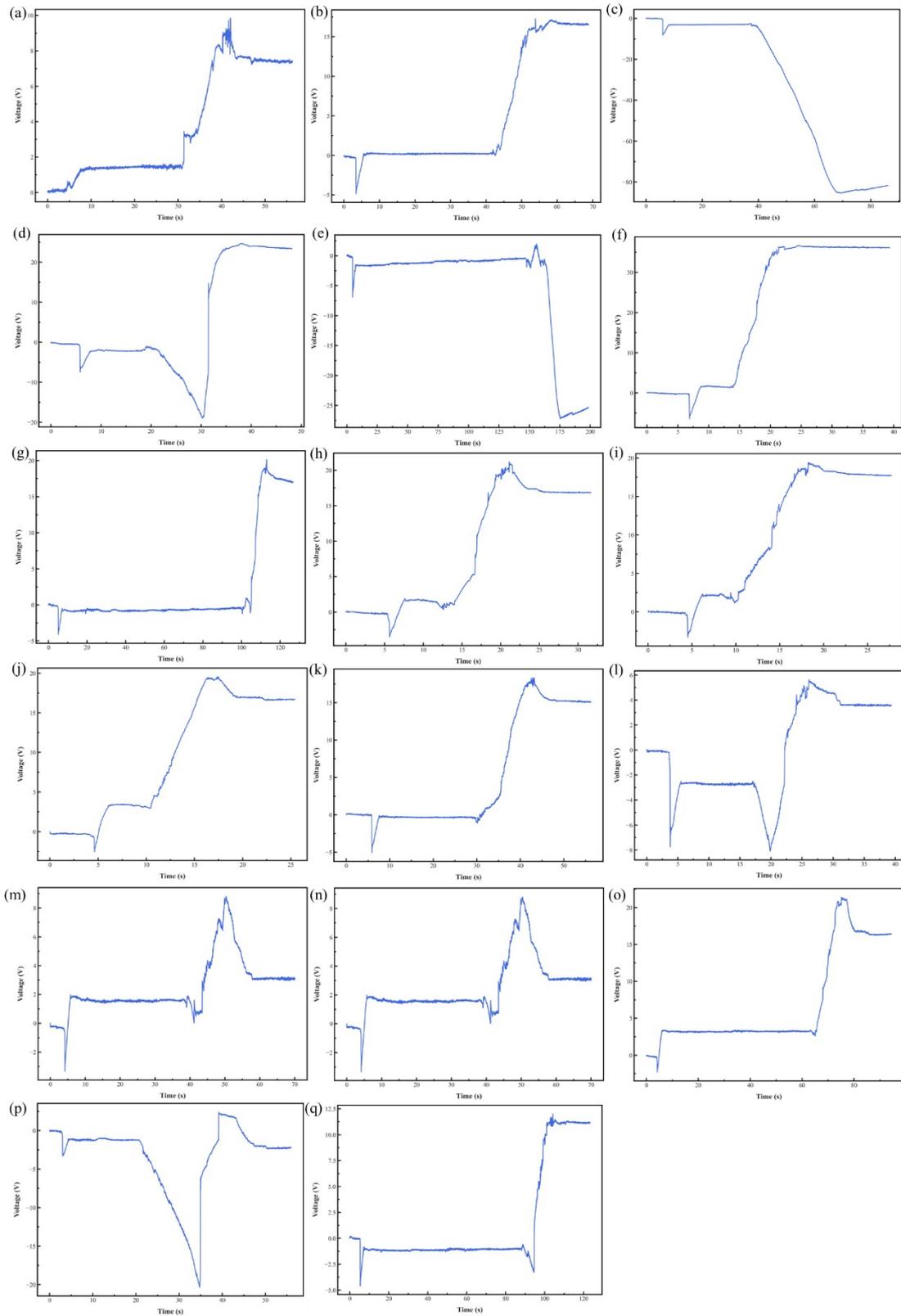


Figure S7. PS Spherical 2 μm : (a) $C=0.1\times 10^{-5}$ g/mL; (b) 0.2×10^{-5} g/mL; (c) 0.3×10^{-5} g/mL; (d) 0.4×10^{-5} g/mL; (e) 0.5×10^{-5} g/mL; (f) 0.6×10^{-5} g/mL; (g) 0.7×10^{-5} g/mL; (h) 0.8×10^{-5} g/mL; (i) 0.9×10^{-5} g/mL; (j) 1.0×10^{-5} g/mL; (k) 1.1×10^{-5} g/mL; (l) 1.2×10^{-5} g/mL; (m) 1.3×10^{-5} g/mL; (n) 1.4×10^{-5} g/mL; (o) 1.5×10^{-5} g/mL; (p) 1.6×10^{-5} g/mL; (q) 1.7×10^{-5} g/mL