Flexible pressure sensors based on carbonized eletrospun PAN fiber films containing ZIF-67 nanoparticles for human motion detection

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Supplementary Information

Preparation of interdigitated electrodes and assembly of pressure sensors

Poly (pyrrole-4,4'-oxydianiline) and amic acid solution (Sigma-Aldrich) were spin-coated on a silicon wafer, cured at 150 °C for 5 min, and further cured at 250 °C for 1 h to prepare polyimide (PI) thin films. Au interdigitated electrodes were patterned on the PI-coated Si wafer using photolithography (electrode width = 200 μm; gap = 100 μm; effective piezoresistive area = 3 mm × 3 mm). Subsequently, the thermally evaporated samples were immersed in acetone, isopropanol, and deionized water to remove the photoresist and obtain clean gold electrodes. Preparation of the flexible piezoresistive sensor involved assembling C-ZIF-67@PAN nanofibers on cross electrodes and encapsulating them with a 1.4 μm polyethylene naphthalate (PEN) film.

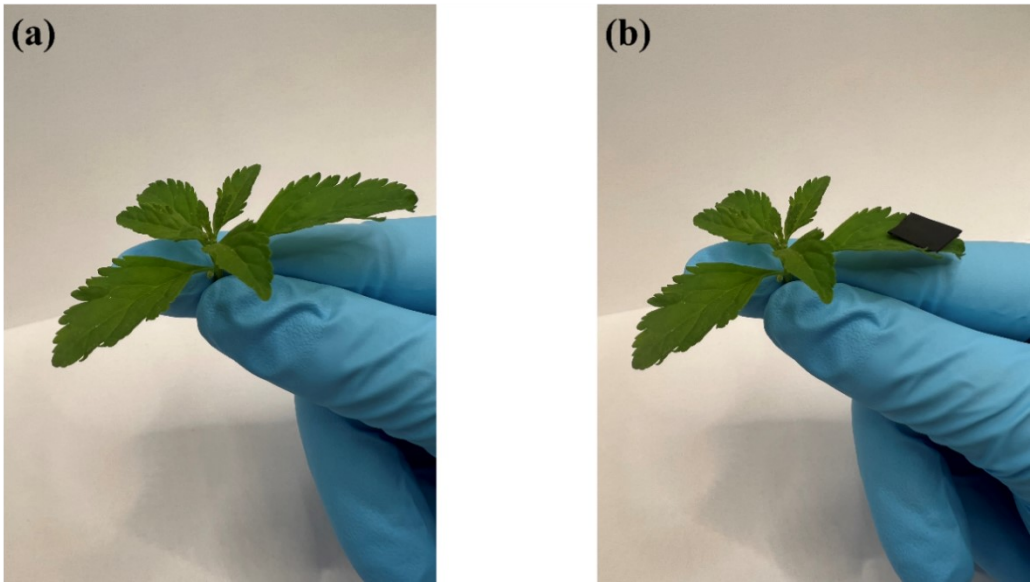

Fig. S1. (a) Initial image of an unpressed leaf of a certain plant. (b) Image of the plant leaf after the placement of C-ZIF-67@PAN fibers.

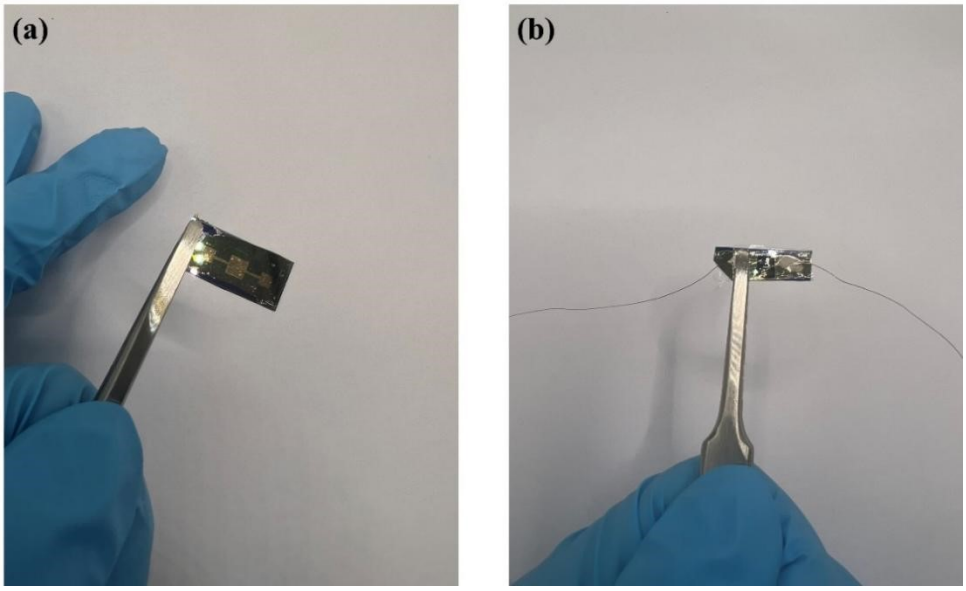

Fig. S2. (a) Interdigitated electrodes patterned on a PI film. (b) Piezoresistive material placed on the interdigitated electrode and encapsulated with a PEN film.

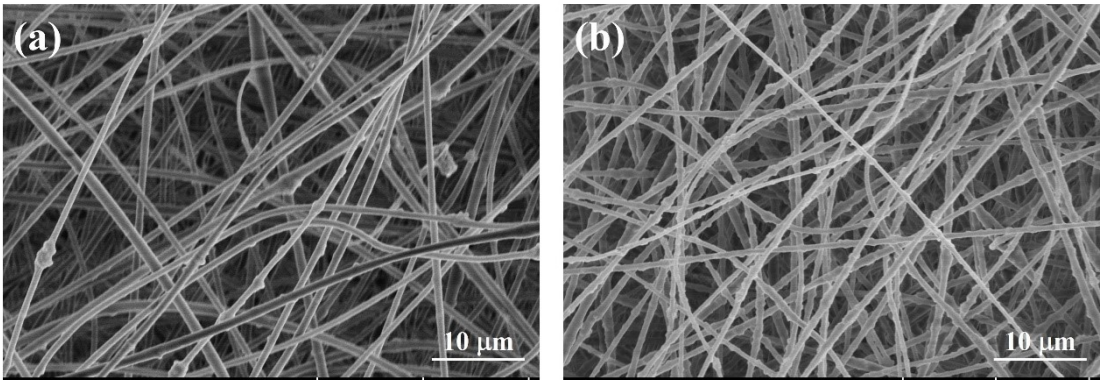

Fig. S3. Electrospun PAN fibers with different mass fractions of ZIF-67 nanoparticles: (a) 10wt% and (b) 25wt%.

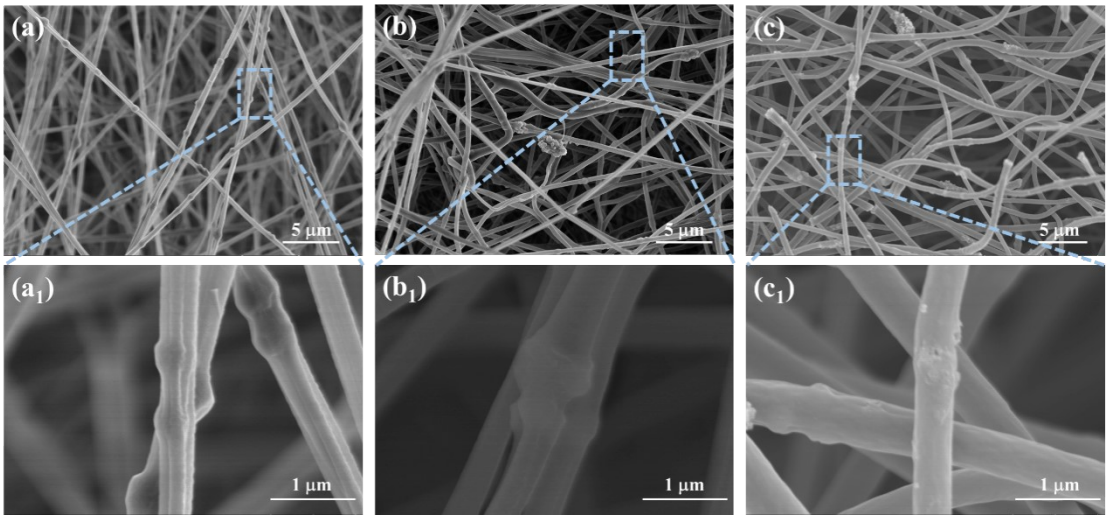

Fig. S4. Low-magnification SEM images of PAN electrospun fiber film with 10% mass fraction of ZIF-67 nanoparticles: (a) at room temperature, (b) after pre-oxidation at 250°C, (c) after carbonization at 800 °C. (a_1), (b_1) and (c_1) show respective high-magnification SEM images at same conditions.

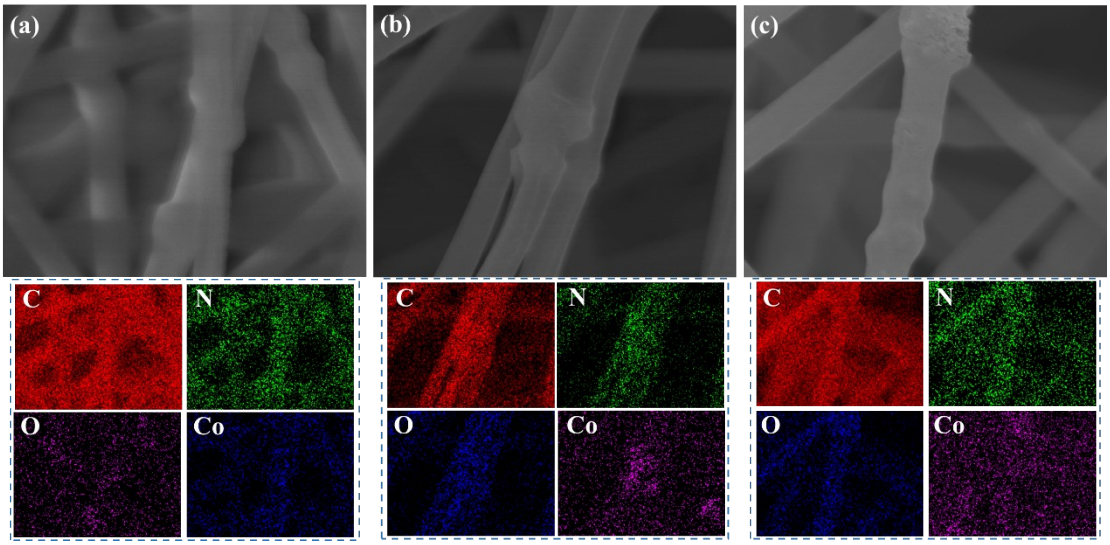

Fig. S5. EDS images and associated elemental distribution of PAN electrospun fiber film with 10% mass fraction of ZIF-67 nanoparticles: (a) at room temperature, (b) after oxidation at 250°C, (c) after carbonization at 800 °C.

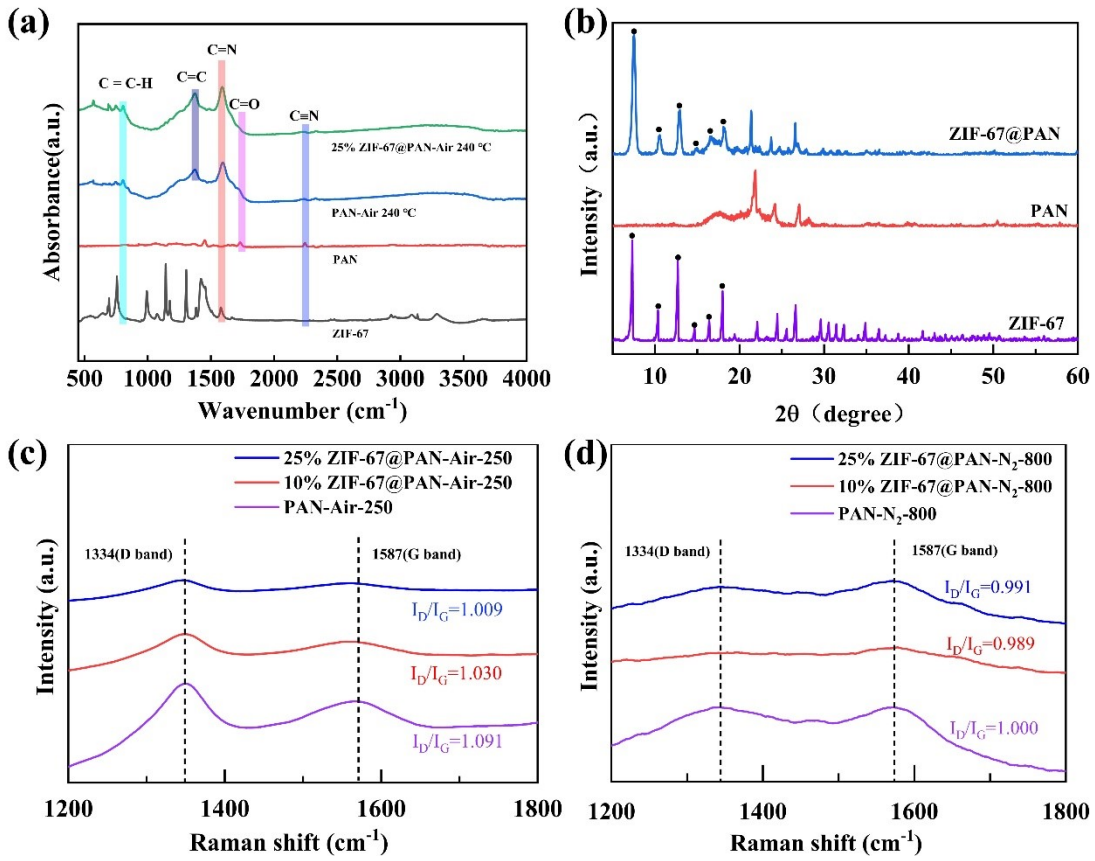

Fig. S6. Material characterization of composite fibers. (a) Infrared spectra of ZIF-67, PAN, PAN after pre-oxidation, and PAN after ZIF-67 loading. (b) X-ray diffraction patterns of ZIF-67, PAN, and ZIF-67@PAN. (c) Raman spectra of oxidized PAN and PAN films containing different amounts of ZIF-67. (d) Raman spectra of carbonized PAN and PAN films containing different amounts of ZIF-67.

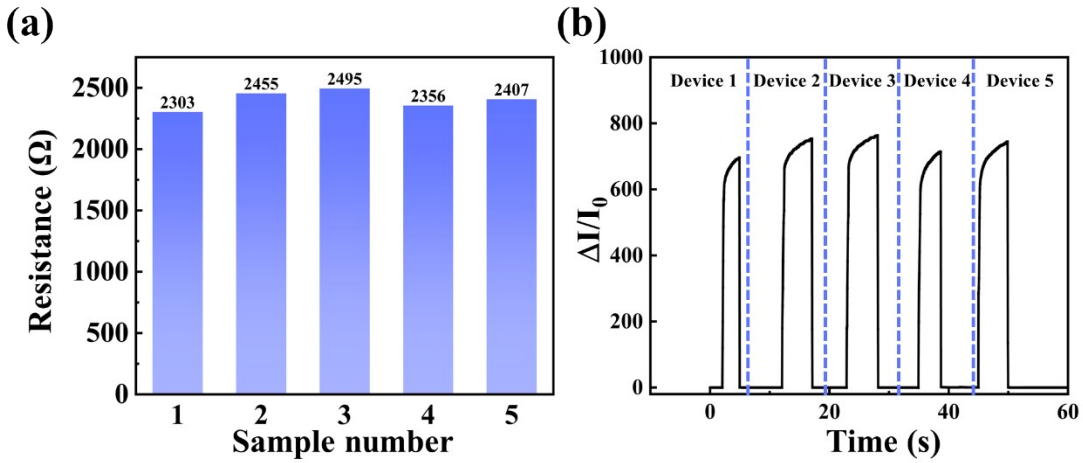

Fig. S7. (a) The resistance and (b) detection response curves for five C-ZIF-67@PAN flexible pressure sensors under the same applied force.

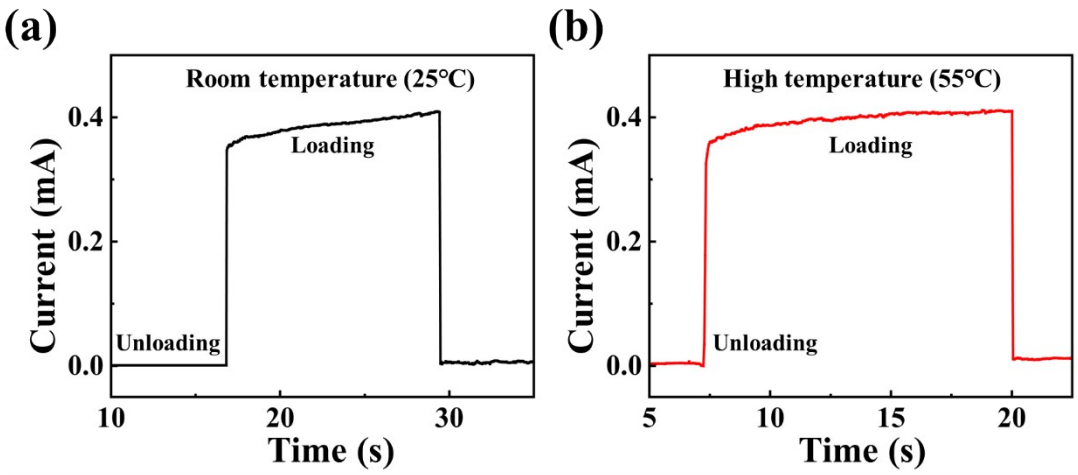

Fig. S8. Current change curves of C-ZIF-67@PAN flexible pressure sensors under loading/unloading at (a) room temperature and (b) elevated temperature (i.e., 55 °C).

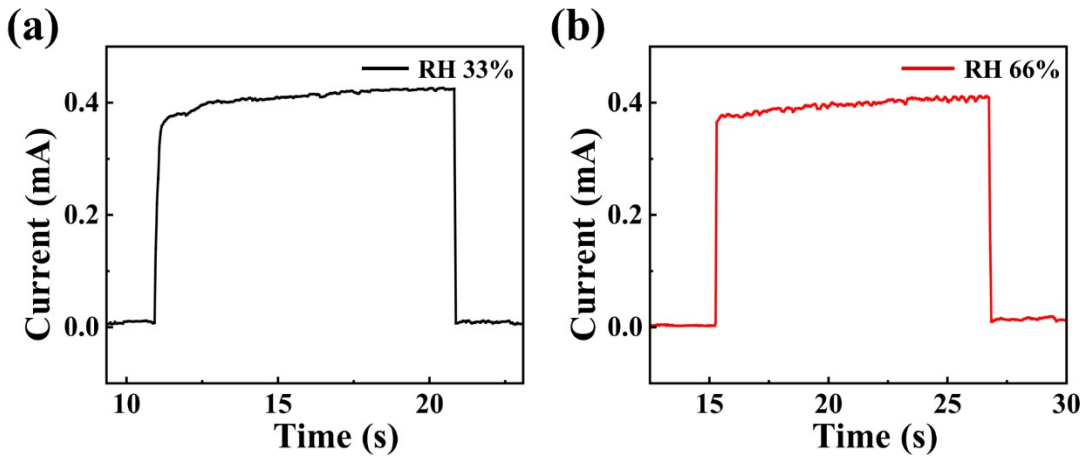

Fig. S9. Current change in the C-ZIF-67@PAN flexible pressure sensor during loading/unloading in (a) low and (b) high humidity environment.

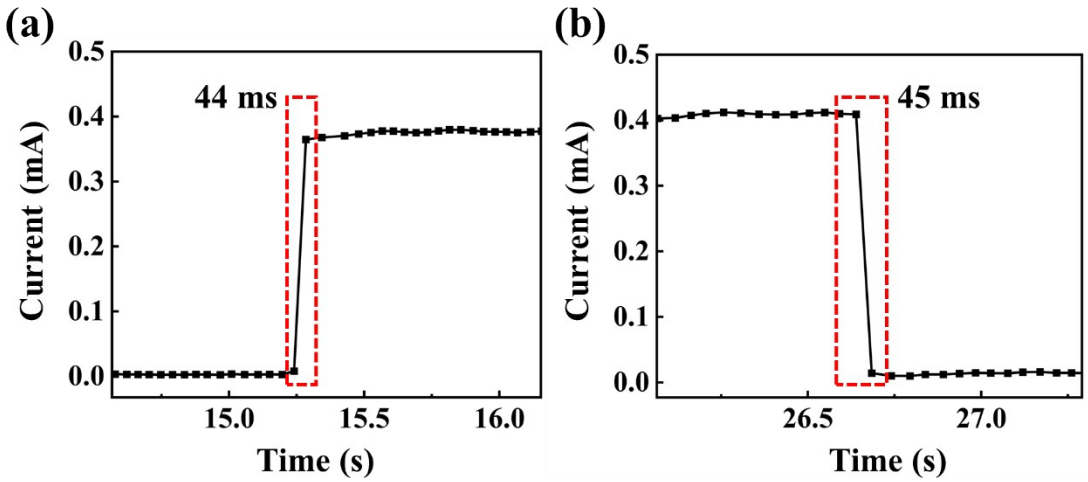

Fig. S10. Current versus time curves of C-ZIF-67@PAN flexible pressure sensors during (a) loading and (b) unloading.

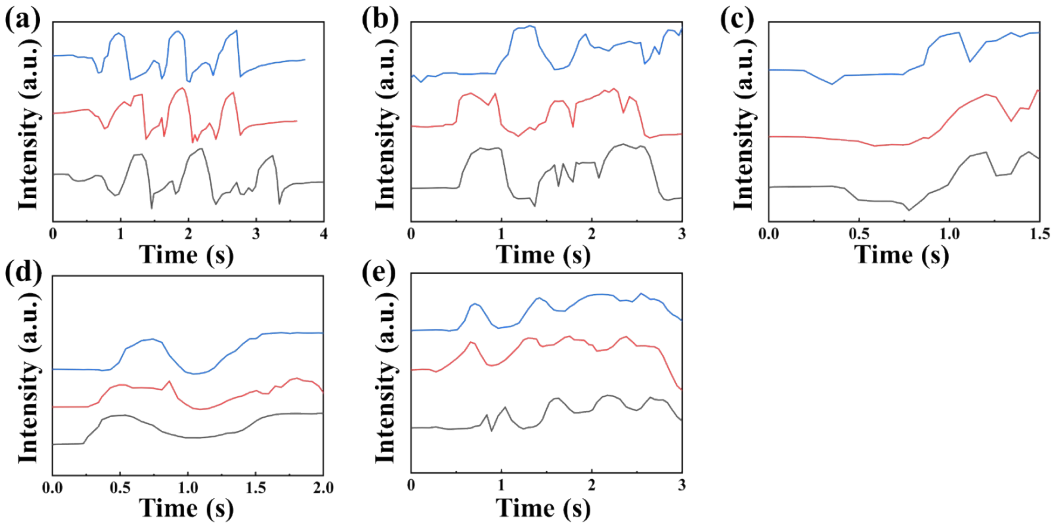

Fig. S11. The output waveform from a sensor attached to the knuckle of a index finger which was repeatedly writing letters: (a)”A”, (b)”B”, (c)”C”, (d)”D” and (e)”E”.

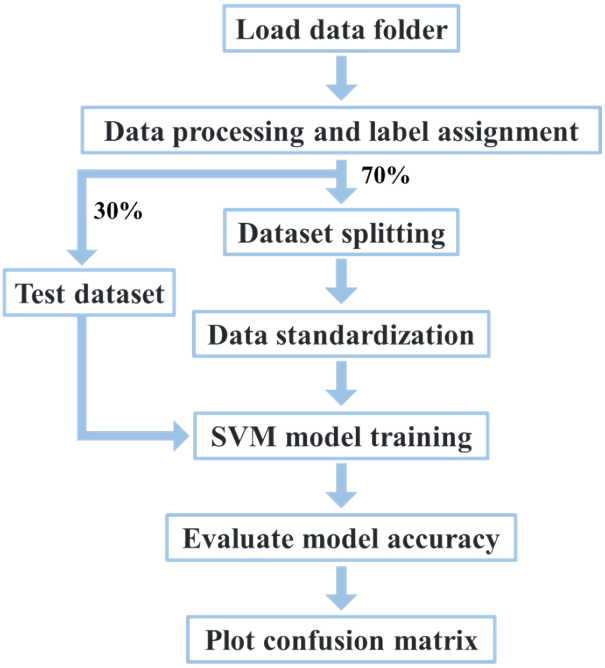

Fig. S12. Flowchart of letter recognition using SVM machine learning.

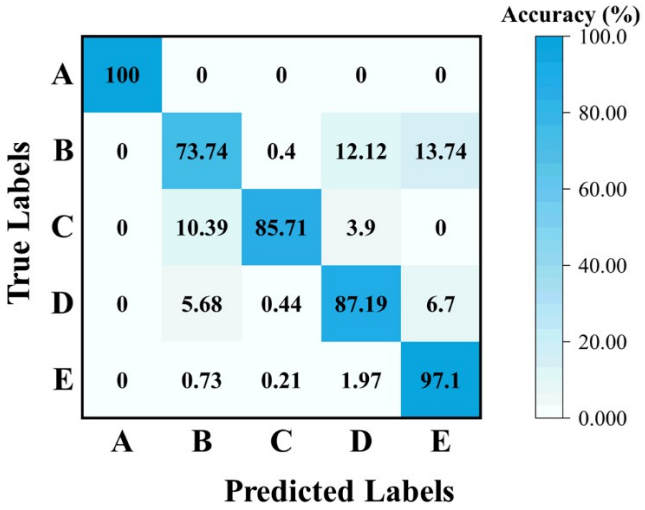

Fig. S13. Recognition accuracy for handwriting of letters without selected penalty coefficient (C) and kernel radius (g) for SVM.