

Supplementary Information

Modified MXene Composite Sensor with Sulphur Impurities for Electrochemical Detection of Lead in Aqueous System

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SI-1: Fabrication of Plastic Chip Electrode (PCE)

Firstly, a thick solution of PMMA was made by dissolving it in chloroform. Graphite powder was then added to the PMMA solution, forming a viscous mixture, which was subjected to ultrasonication for 15 minutes to ensure uniform dispersion and optimal consistency. This PMMA-graphite suspension was poured into a custom glass mold and allowed to stand at room temperature for 24 hours to enable complete chloroform evaporation. The resulting PCE sheets, approximately $380 \pm 10 \mu\text{m}$ thick, had a resistance of about $28 \pm 2 \Omega$. These sheets were then cut into $1.5 \times 1 \text{ cm}^2$ pieces and laminated manually with a cello tape to fix the exposed surface area, with a circular active area of 0.28 cm^2 (excluding contact regions), preparing them for subsequent experimental applications.

SI-2: Electrochemical active surface area of bare PCE, composite electrodes

CV at different scan rates in 5.0 mM ($\text{K}_4[\text{Fe}(\text{CN})_6]$) solution with 0.1 M KCl were recorded of bare PCE, TiMX/PCE, S-Bi/PCE, and S-Bi@TiMX/PCE, as shown in Figure S1. The electrochemical surface areas of bare PCE, TiMX/PCE, S-Bi/PCE, and S-Bi@TiMX/PCE were calculated using slopes of corresponding calibration plots in Randles-Sevcik equation (Equation S1):

$$I_p = (2.69 \times 10^5) A C n^{3/2} D^{1/2} \nu^{1/2} \quad (\text{i})$$

Where,

I_p corresponds anodic peak current (A),

A corresponds to electrochemical active surface area of electrode (cm^2),

C refers to concentration of (mol/cm^3),

n denotes number of electrons involved in the redox process ($n=1$),

D stands for diffusion coefficient of analyte ($\text{Fe}[\text{CN}_6]^{-3/-4}$) ($D = 7.6 \times 10^{-6} \text{ cm}^2/\text{s}$)

v denotes scan rate (V/s)

The electrochemical active surface areas of PCE, TiMX/PCE, S-Bi/PCE, and S-Bi@TiMX/PCE were calculated to be 0.009, 0.0120, 0.015 and 0.028 cm^2 , respectively.

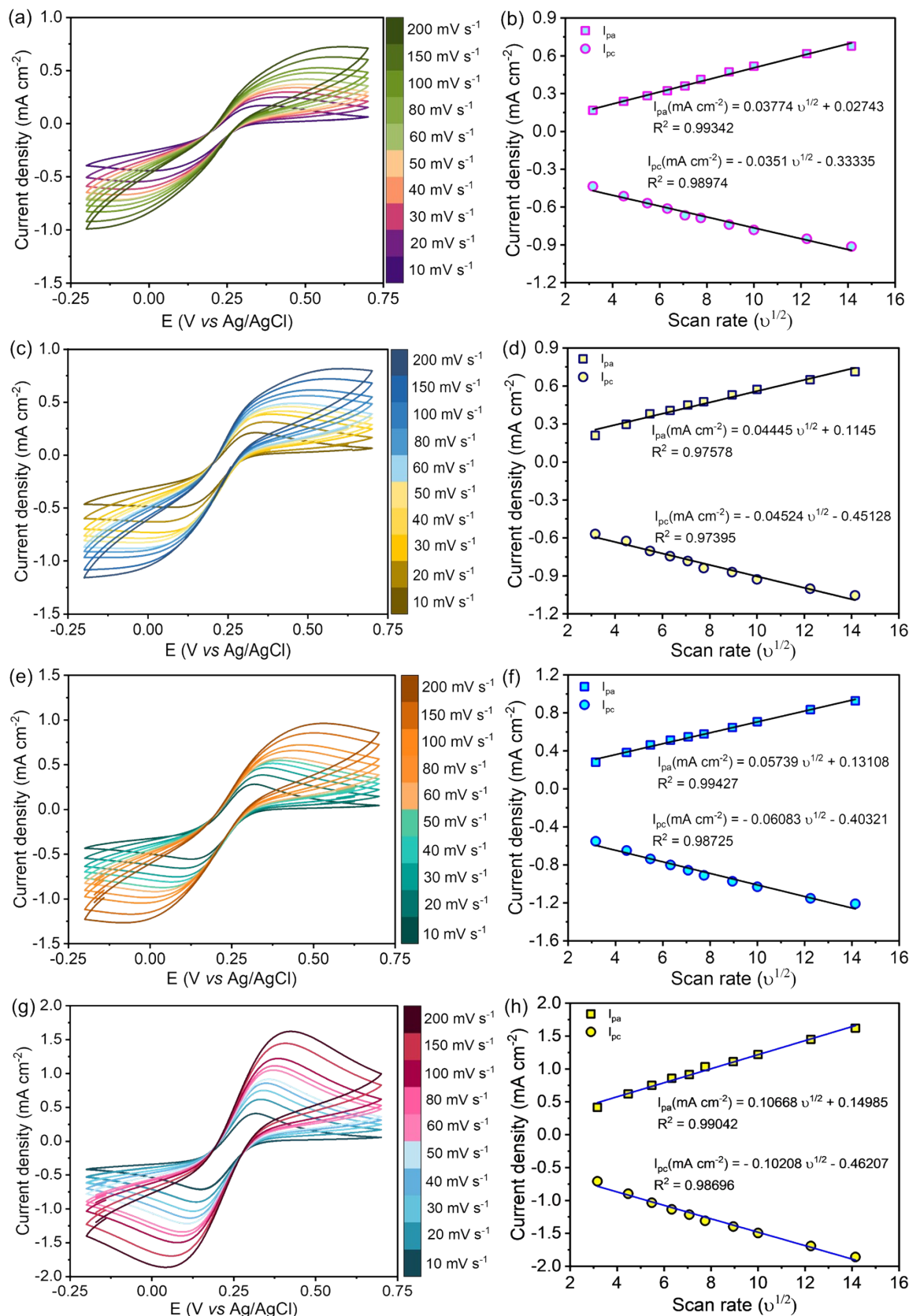


Figure. S1 (a), (c), (e), and (g) CVs of bare PCE, TiMX/PCE, S-Bi/PCE, and S-Bi@TiMX/PCE at different scan rates in 5.0 mM ($K_4[Fe(CN)_6]$) solution with 0.1 M KCl, and (b), (d), (f), and (h) corresponding linear calibration plots of anodic and cathodic peak current densities.