

Fig. S1 SEM images of $\text{Sn}_{0.5}\text{Bi}$ catalyst electrodeposited at different temperatures (a) 25°C (b) 30°C (c) 35°C (d) 40°C (e) 45°C

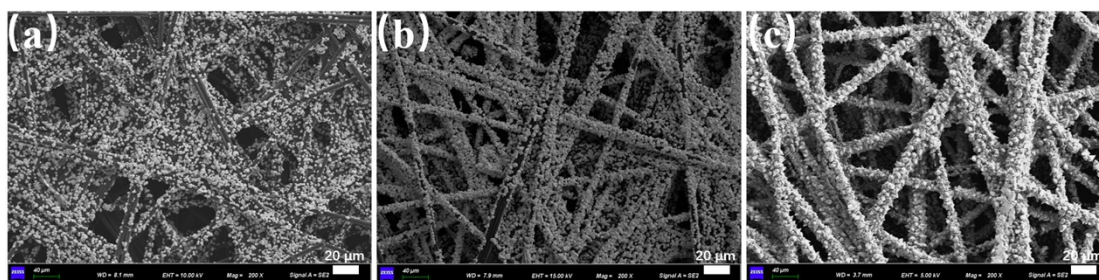


Fig. S2 Magnified SEM images of $\text{Sn}_{0.5}\text{Bi}$ catalyst under different deposition current densities (a) $1 \text{ mA} \cdot \text{cm}^{-2}$ (b) $2 \text{ mA} \cdot \text{cm}^{-2}$ (c) $3 \text{ mA} \cdot \text{cm}^{-2}$

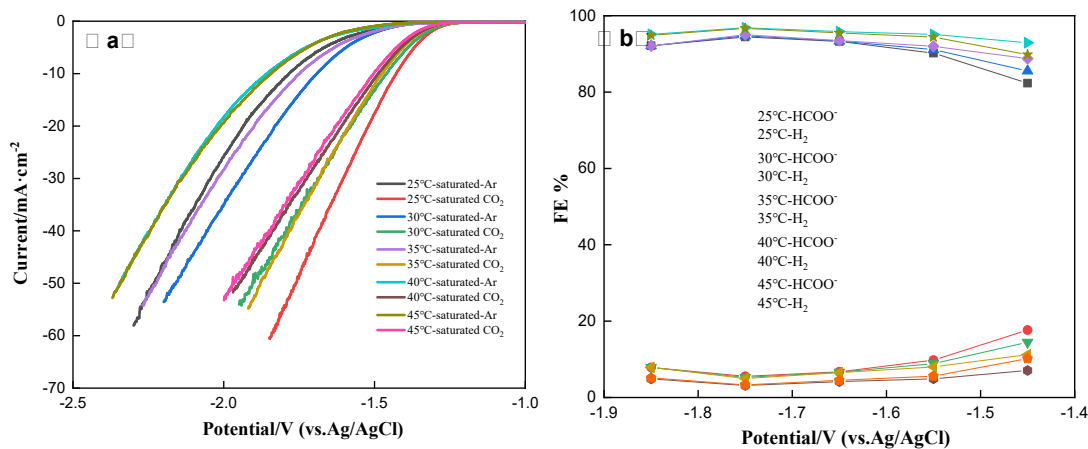


Fig. S3 Performance test diagram of $\text{Sn}_{0.5}\text{Bi}$ catalyst electrodeposited at different temperature (a) LSV (b) FE-

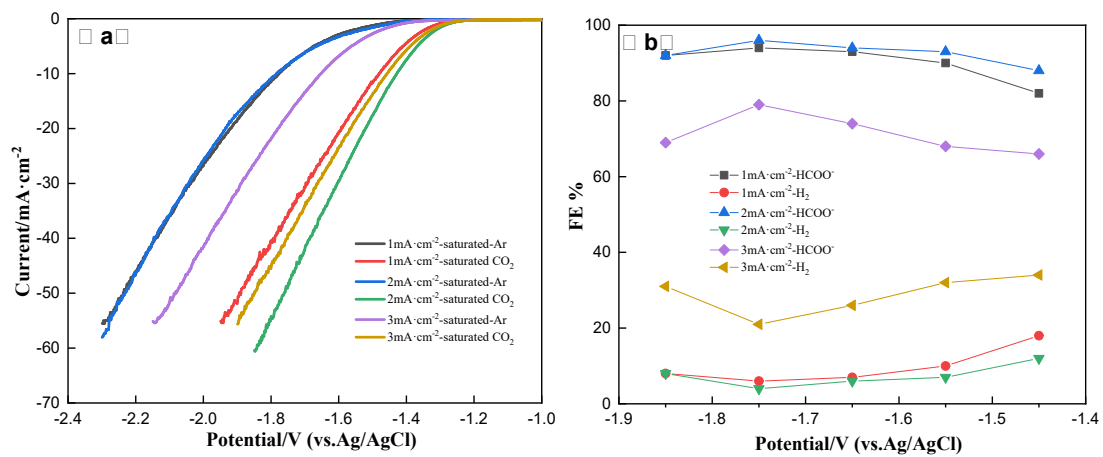


Fig. S4 Performance test diagram of Sn_{0.5}Bi catalyst under different deposition current densities (a) LSV (b)

FE-E

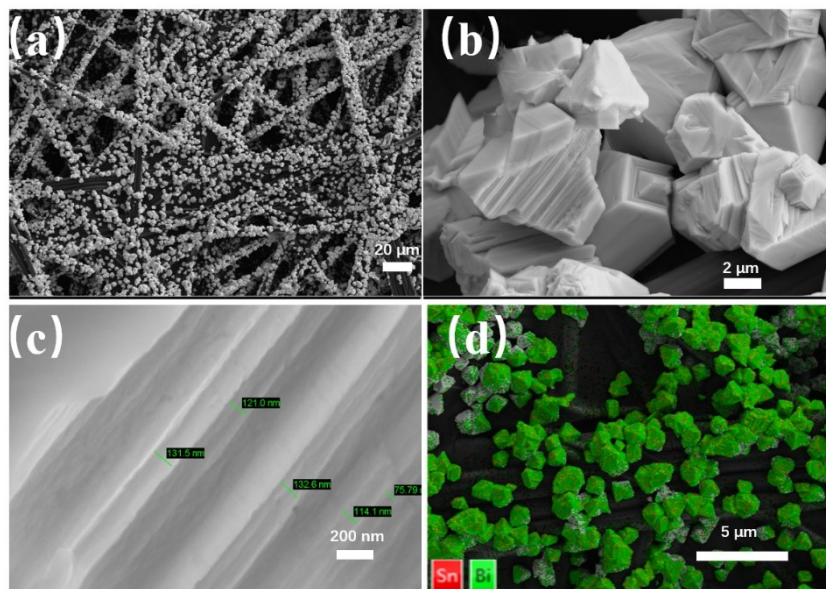


Fig. S5 The SEM image of Sn_{0.25}Bi catalyst (a) 20 μm (b) 2 μm (c) 200 nm (d) Mapping map (Bi is green, Sn is red)

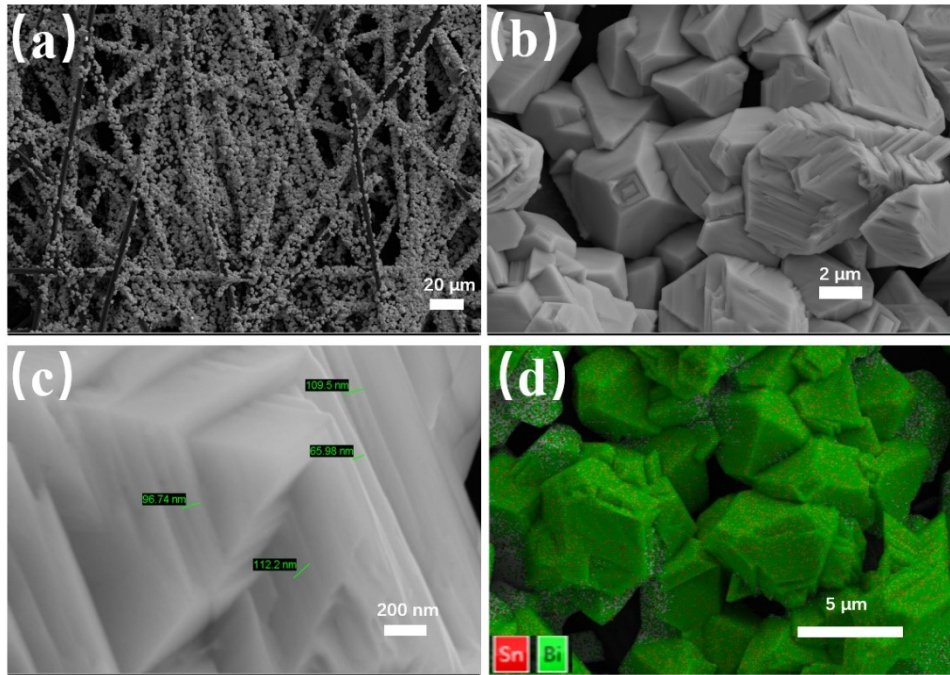


Fig. S6 The SEM image of Sn_{0.75}Bi catalyst (a) 20 μm (b) 2 μm (c) 200 nm (d) Mapping map (Bi is green, Sn is red)

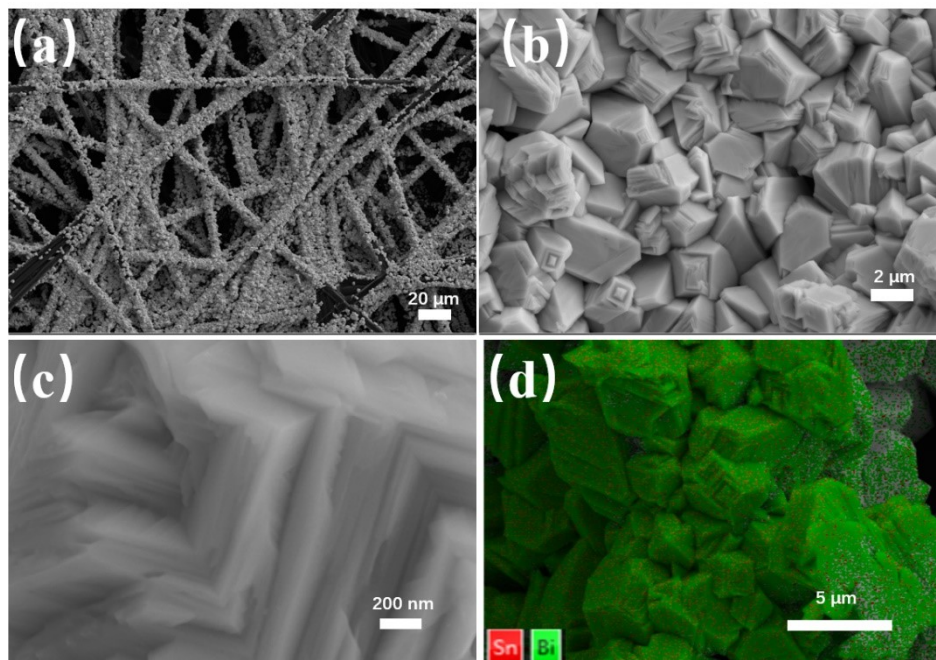


Fig. S7 The SEM image of Sn₁Bi catalyst (a) 20 μm (b) 2 μm (c) 200 nm (d) Mapping map (Bi is green, Sn is red)

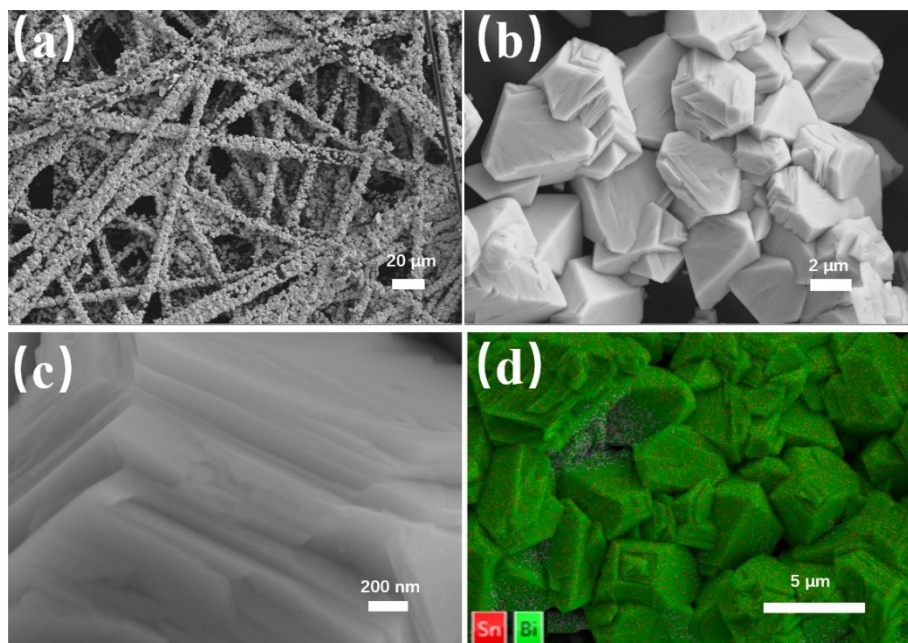


Fig. S8 The SEM image of $\text{Sn}_{1.25}\text{Bi}$ catalyst (a) 20 μm (b) 2 μm (c) 200 nm (d) Mapping map (Bi is green, Sn is red)

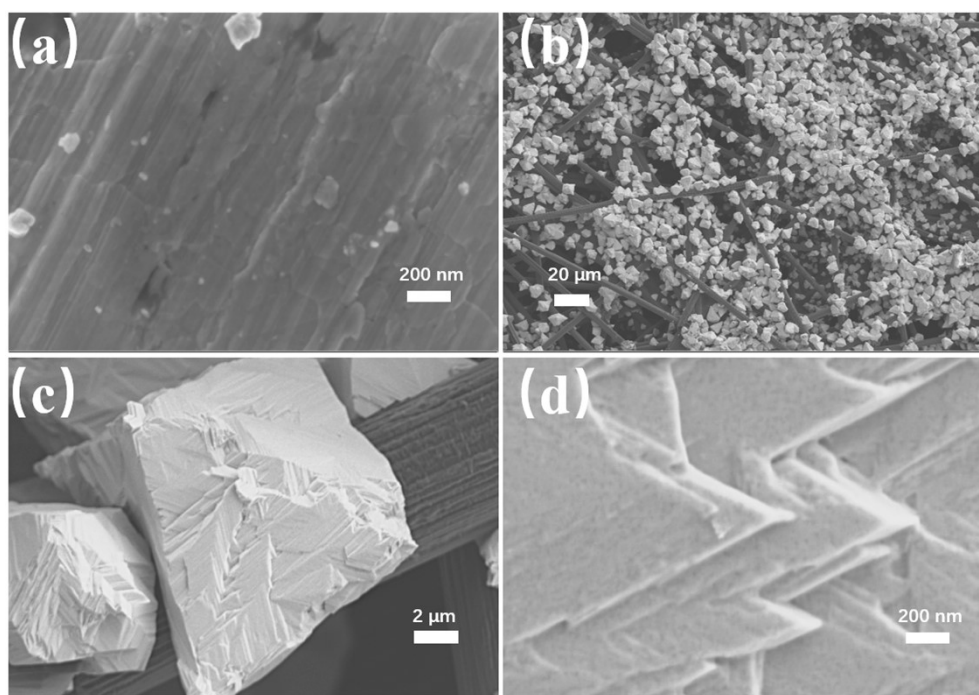


Fig. S9 The SEM images of pure Bi materials (a) Commercial pure Bi 200 nm ; Electrodeposited pure Bi (b) 20 μm (c) 2 μm (d) 200 nm

Table S1 Proportion of micro surface elements of each SnBi catalyst

Sn ²⁺ /Bi ³⁺ molar ratio	Bi (%)	Sn (%)
0.25	97.33	2.68
0.5	97.66	2.33
0.75	95.25	4.75
1	94.29	5.71
1.25	93.89	6.1

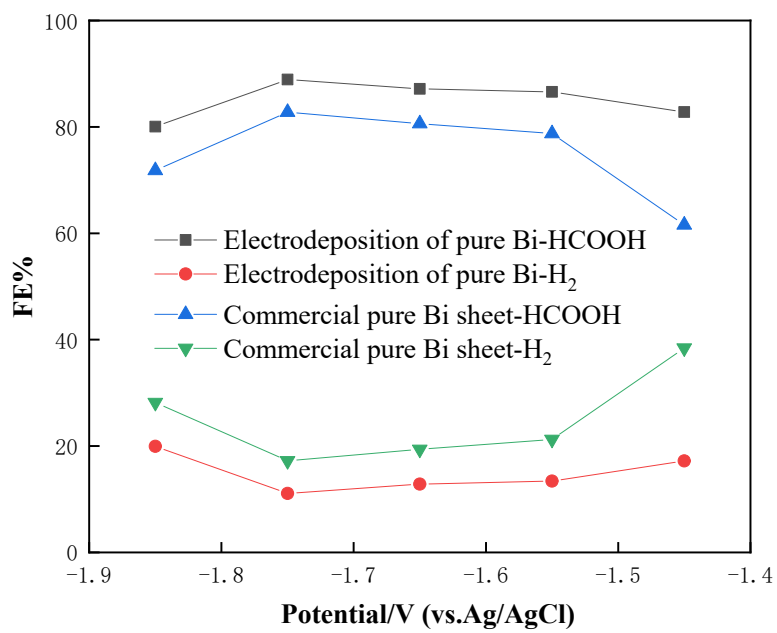


Fig. S10 Performance test chart of SnBi catalyst materials (a) Cdl (b) LSV (c) FE-E ; Performance test diagram of pure Bi (d) FE-E

Table S2 Proportion of micro surface elements of each SnBi catalyst

Sn ²⁺ /Bi ³⁺ molar ratio is 0.5	Bi (%)	Sn (%)
before reaction	97.66	2.33
after the reaction	98.02	1.98