中国科学技术大学

University of Science and Technology of China

Preparation of High Efficiency Bi-Based CO_2 Electroreduction Catalyst and Its Performance Regulation

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Outline

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Bi-Based Nanomaterials And CO_2 Reduction

- An Attractive Means For the Capture And Utilization of Atmospheric CO_2
- Bi is Low Toxicity, Earth-abundant, Cheaper Than Noble Elements
- Bi-Based Materials Have Shown High Stability And Selectivity
- Most Of The Products Is Formate Under Aqueous Conditions

Bi_2Te_3 Is A Kind Of 3D Topological Insulator

- The Bulk Of Such Materials Is Insulating But The Surface Can Conduct Electric Current Protected By The Time-reversal Symmetry.
- CO_2 Electroreduction Involve Transfer Of Electrons.

Our Group Have Modulated Bi_2Te_3 Nanoplates By Doping And High Temperature Annealing And Studied Their Influence.

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Crystal Preparation

Preparation Of Precursor Slurries

Solvothermal Synthesis

Preparation Of Working Electrode

High Temperature Annealing

Electroreduction Characterization

Physical Characterization

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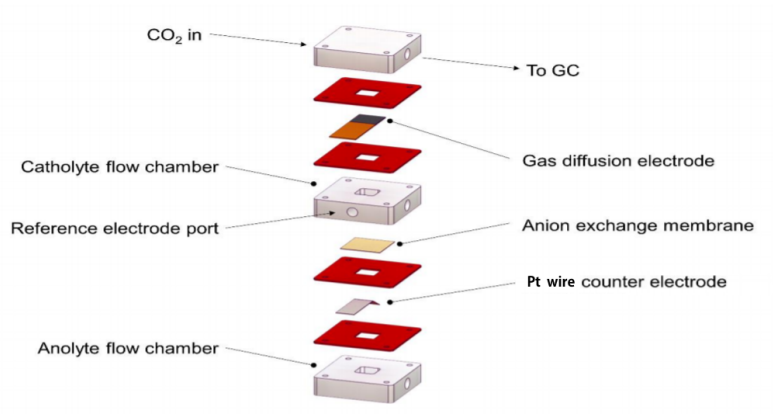
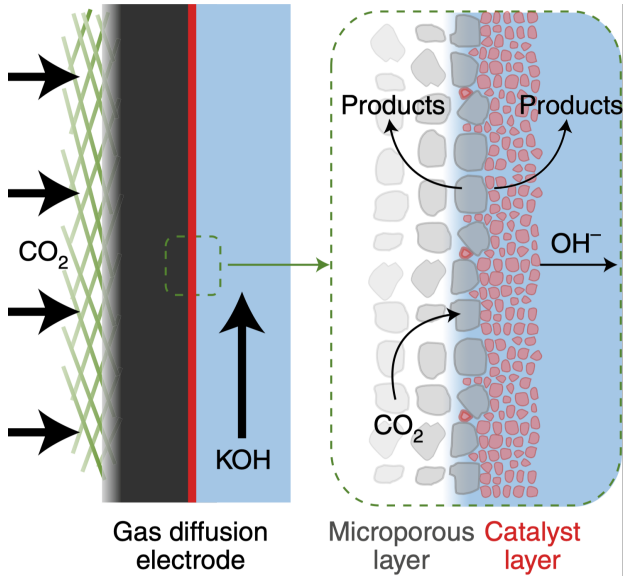
Experimental Apparatus





(a) Schematic Diagram of Flow-cell (b) Schematic Diagram of GDL

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Faradaic Efficiency

$$FE_x = \frac{\textit{the total charge transferred towards product } x}{\textit{the total charge transferred}}$$

Used To Characterize Conversion Efficiency

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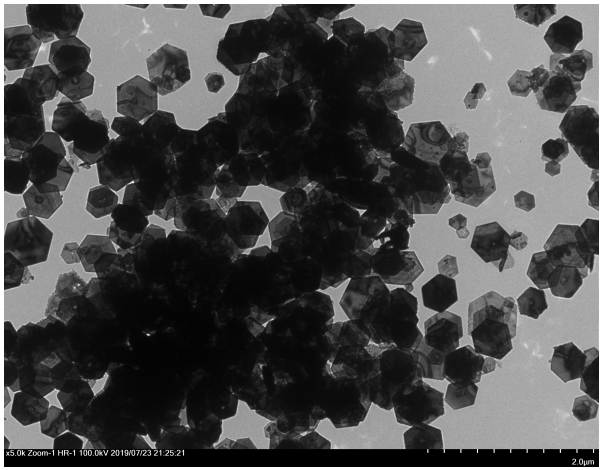
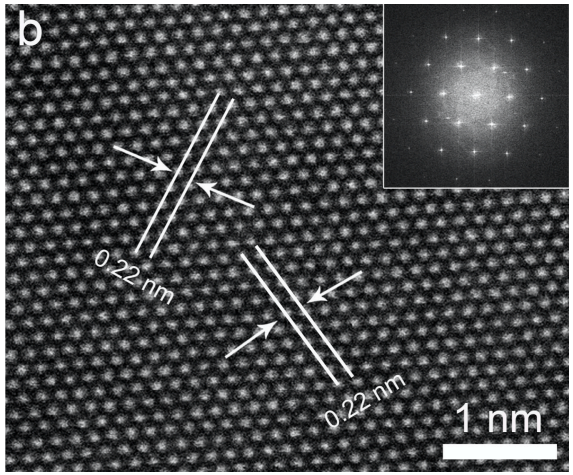
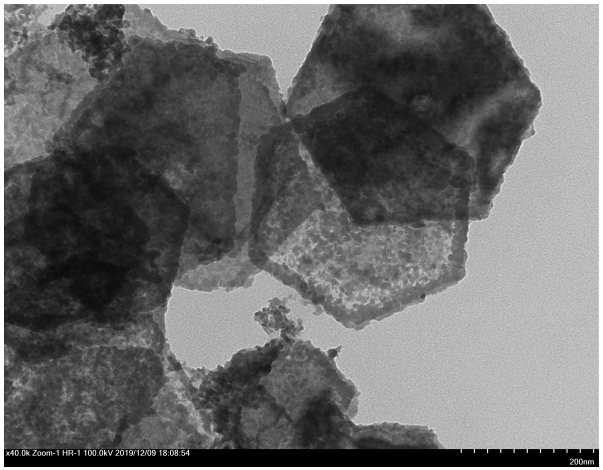
Crystal Morphology



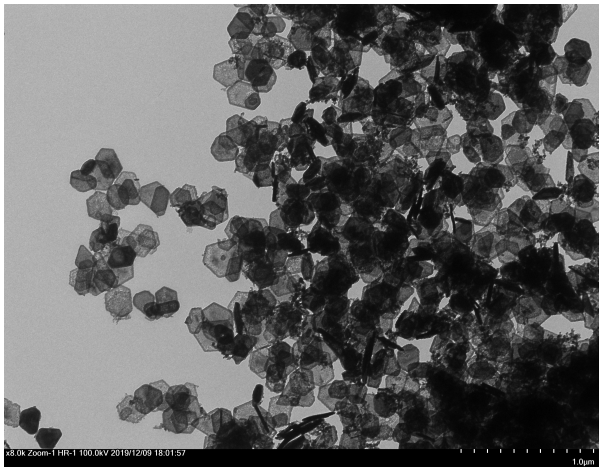
(c) TEM of Bi_2Te_3



(d) HRTEM of Bi_2Te_3



(e) TEM of V doped Bi_2Te_3



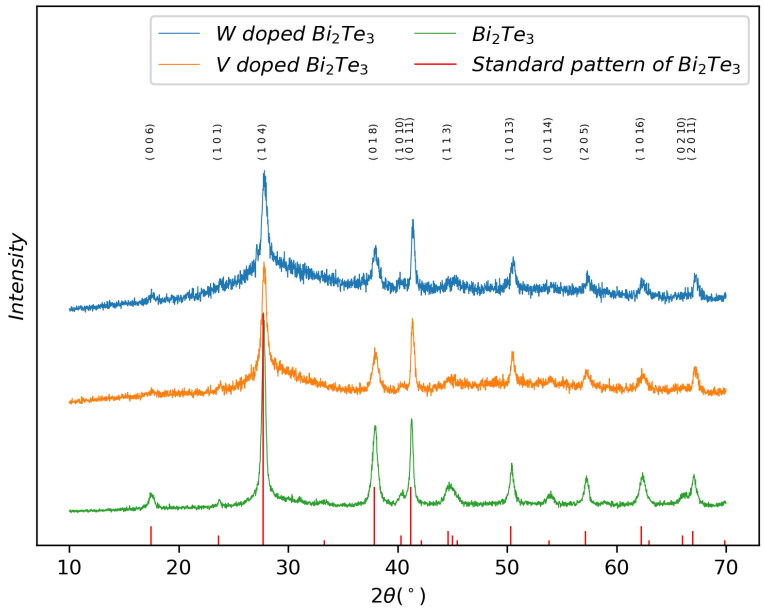
(f) TEM of W doped Bi_2Te_3

The Morphology is Relatively Uniform

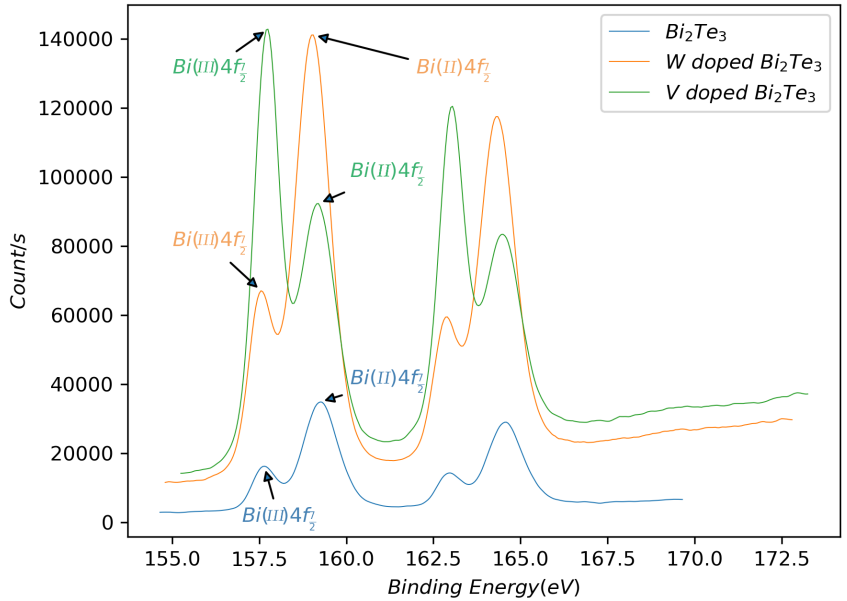
XRD

ICP-AES

XPS



(g) XRD Pattern



(h) XPS Pattern

Characterization Result

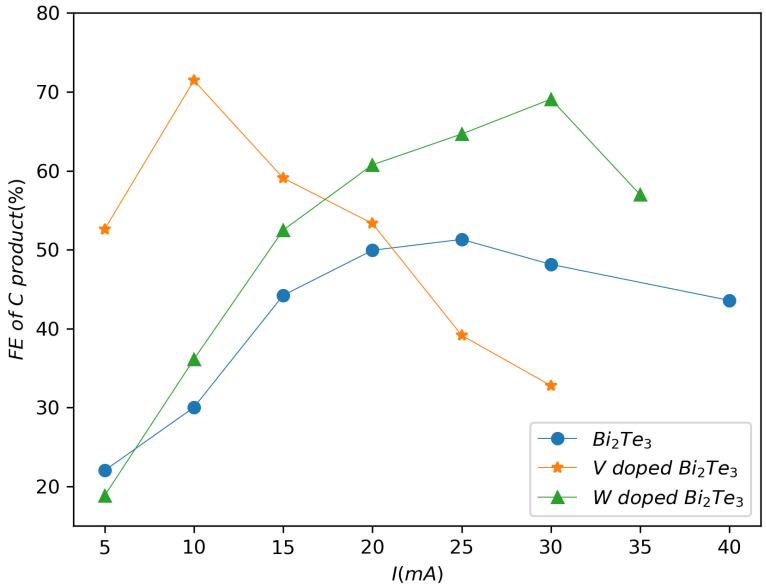
Doping Element x	Bi ($\mu g/mL$)	X ($\mu g/mL$)	X/Bi
V	219.3	0.105	0.002
W	164.3	0.058	0.0003

Table: Result of ICP-AES

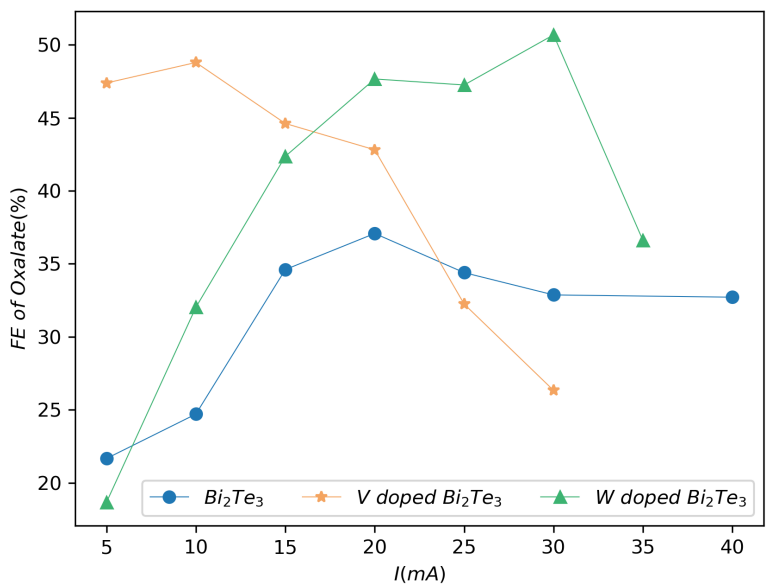
Doping Element x	Bi(%)	Te(%)	Area of Bi(II) $4f_{\frac{7}{2}}$	Area of Bi(III) $4f_{\frac{7}{2}}$	Bi(II)/Bi(III)
	8.35	10.73	49967	10688	4.675
V	11.75	17.34	84732	120658	0.702
W	8.8	12.29	158812	49091	3.235

Table: Result of XPS

- The Chemical Formula: BTs: $Bi_2Te_{2.57}$, VBTs: $Bi_2Te_{2.95}V_{0.004}$, WBTS: $Bi_2Te_{2.79}W_{0.0006}$
- VBTs has more Bi(III)

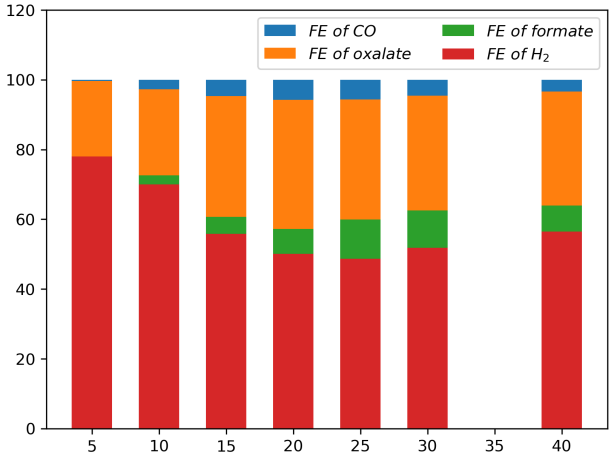


(i) Efficiency of CO_2 Reduction

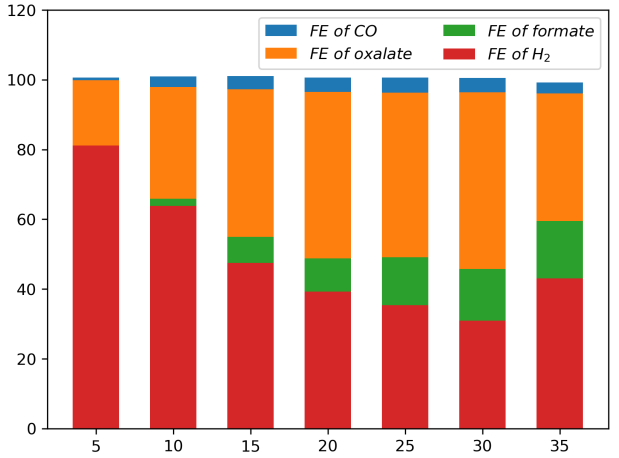


(j) Efficiency of Oxalate

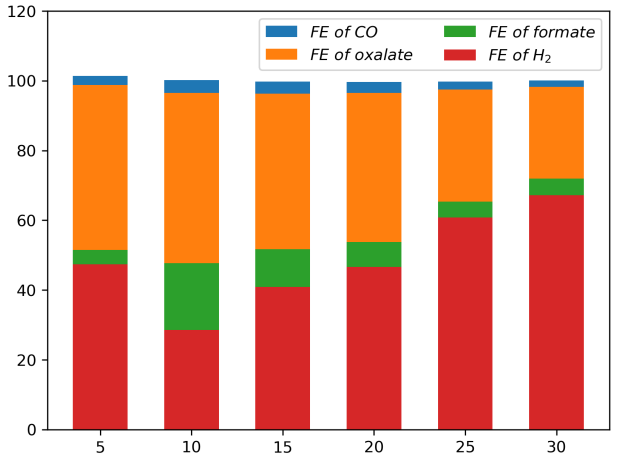
Products Distribution



(k) BTs



(l) WBTs



(m) VBTs

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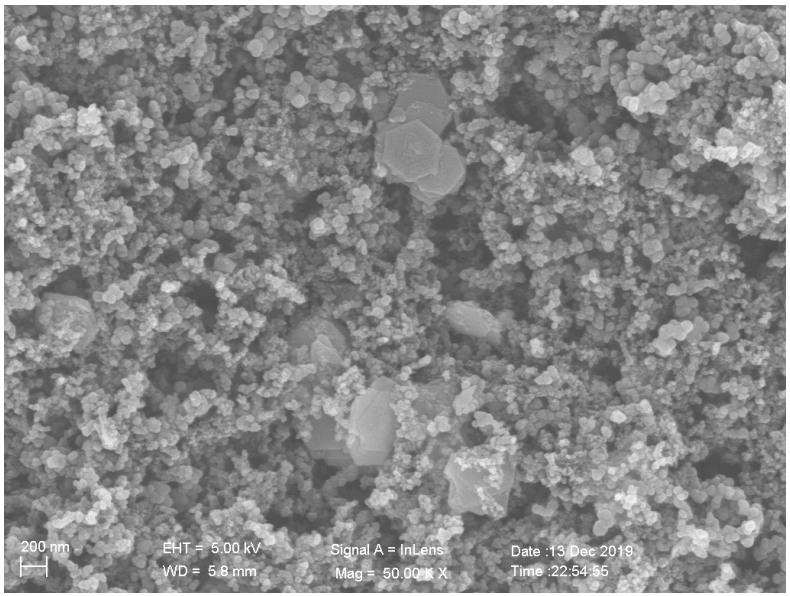
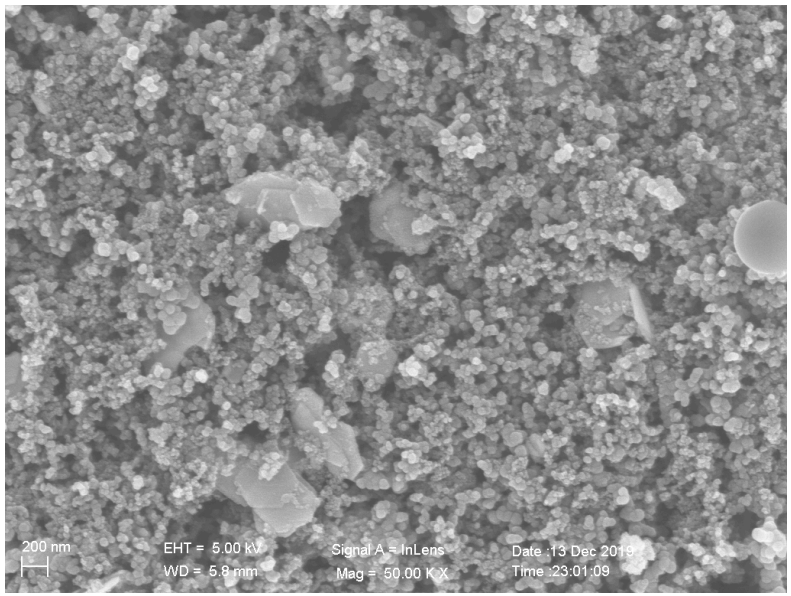
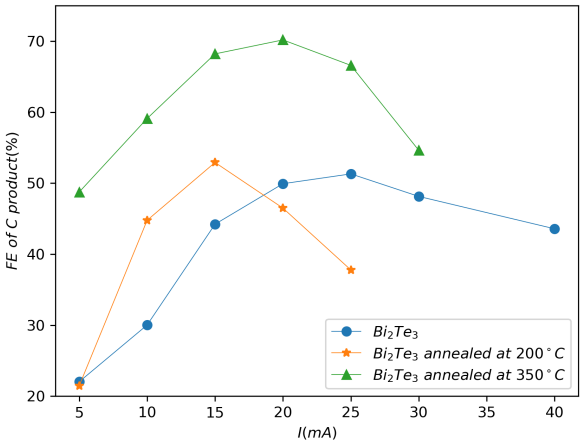


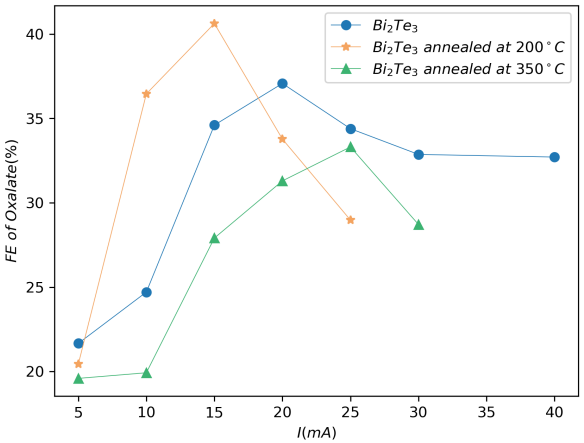
(n) 200°C-1 Hour(BTs-200)



(o) 350°C-1 Hour(BTs-350)



(p) Efficiency of CO_2 Reduction



(q) Efficiency of Oxalate

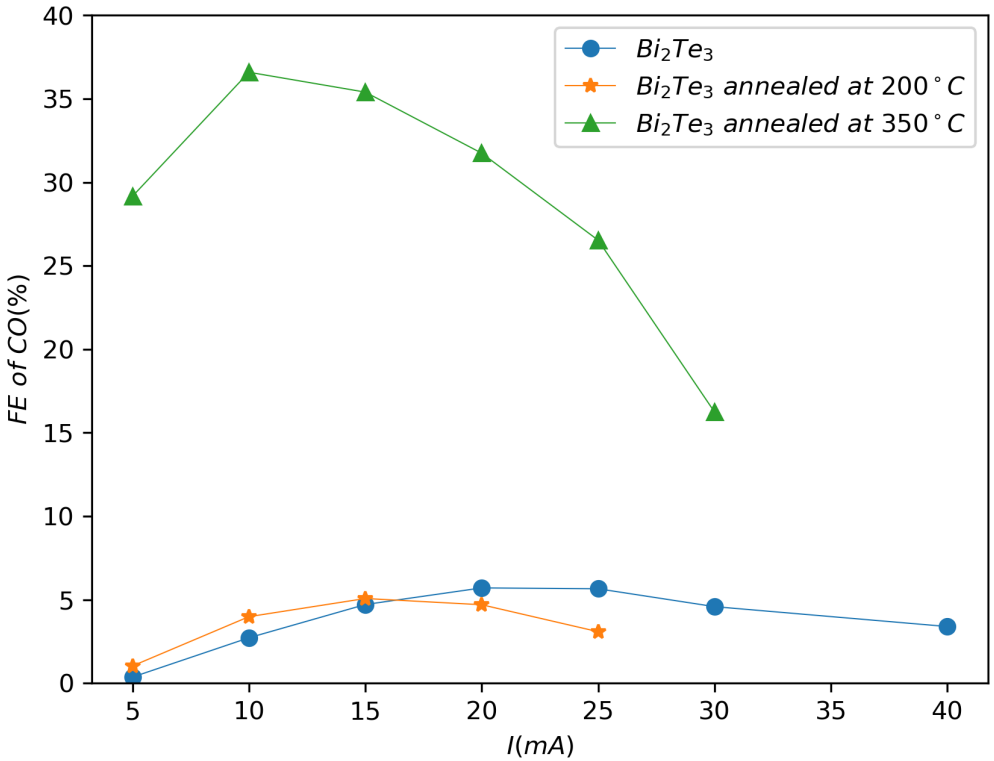
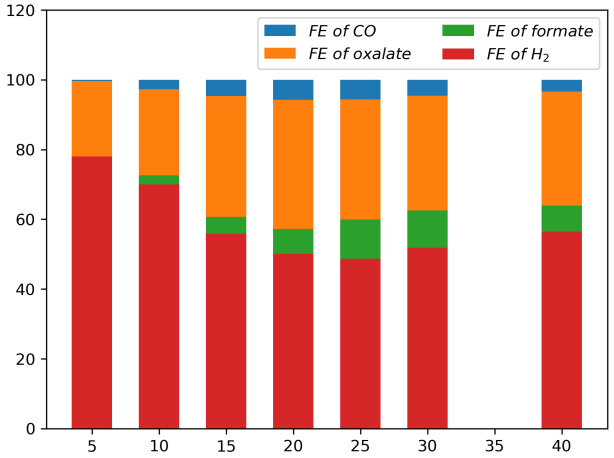
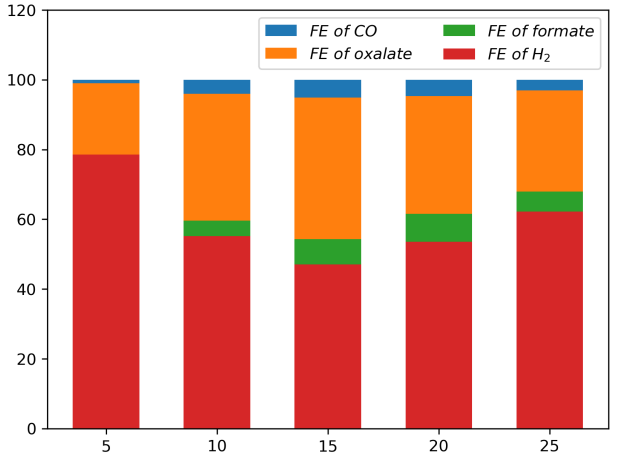


Figure: Efficiency of CO

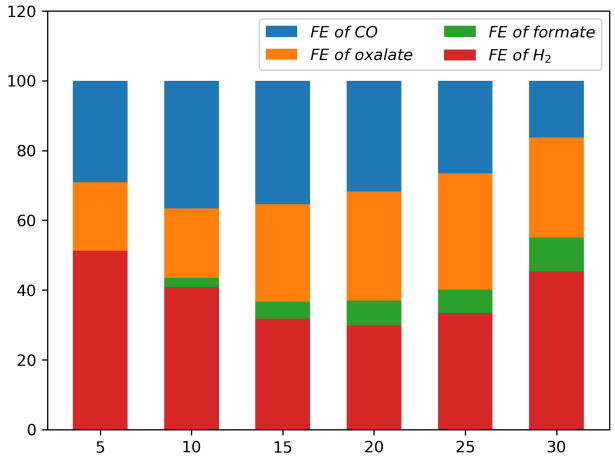
Products Distribution



(a) BTs



(b) BTs-200



(c) BTs-350

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Summary

- Realized Oxalate Products Via Bi-based Materials Through Solvothermal Synthesis
- Modulated Bi_2Te_3 Nanoplates' Fermi Level With 2 Different Approaches, Lower the Difficulty of CO_2 Elecroreduction
- Promoted CO Efficiency Significantly Through High Temperature Annealing

Thanks!