Gate Review #2

SUMMER 2024

RESEARCH EXPERIENCES FOR UNDGRADUATE STUDENTS

Structural Engineering of (Bi/Mn) Double Perovskites for Photodetector Applications

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Synopsis

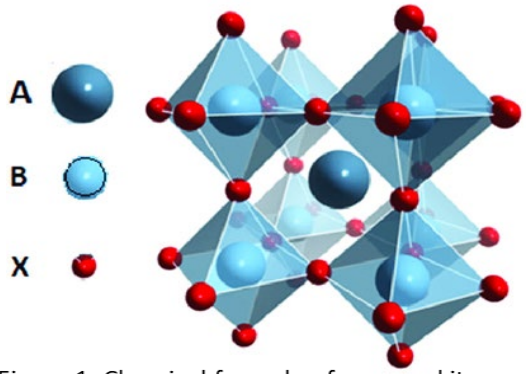

Figure 1: Chemical formula of a perovskite
Masood, Muhammad Talha. (2020). Solution-Processable Compact and Mesoporous Titanium Dioxide Thin Films as Electron-Selective Layers for Perovskite Solar Cells.

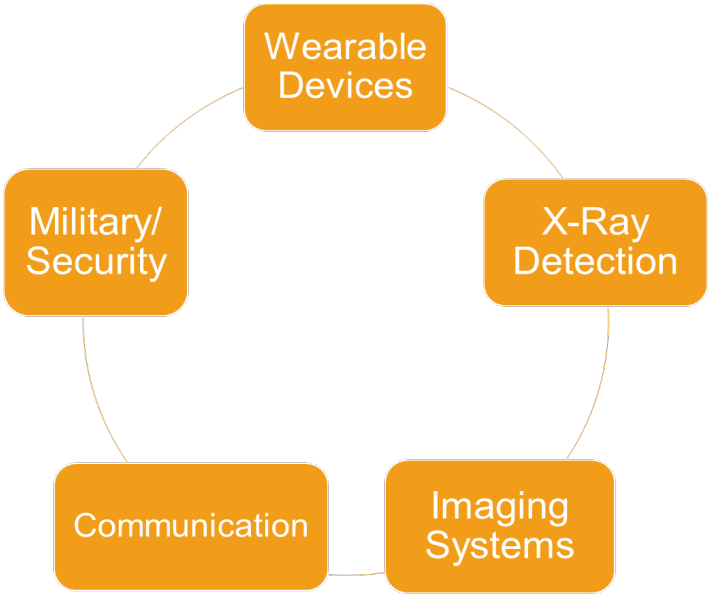

Figure 2. Photodetection Applications

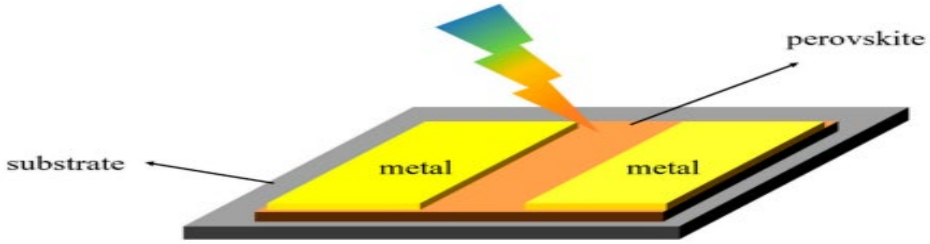

Figure 3. Photoconductor structure diagram.
https://doi.org/ 10.3390/nano12244390

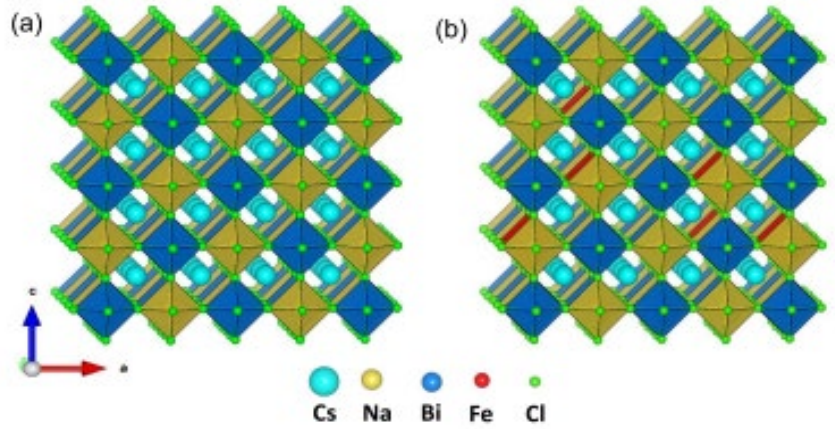

Figure 4. (a) Crystal structure of $Cs_2NaBiCl_6$, (b) Fe-doped $Cs_2NaBiCl_6$ double perovskite sample.
https://doi.org/10.1021/acs.inorgchem.2c04149

Doping the $Cs_4MnBi_2Cl_{12}$ perovskite with iron with the goal of improving certain performance factors.

Experimental Method

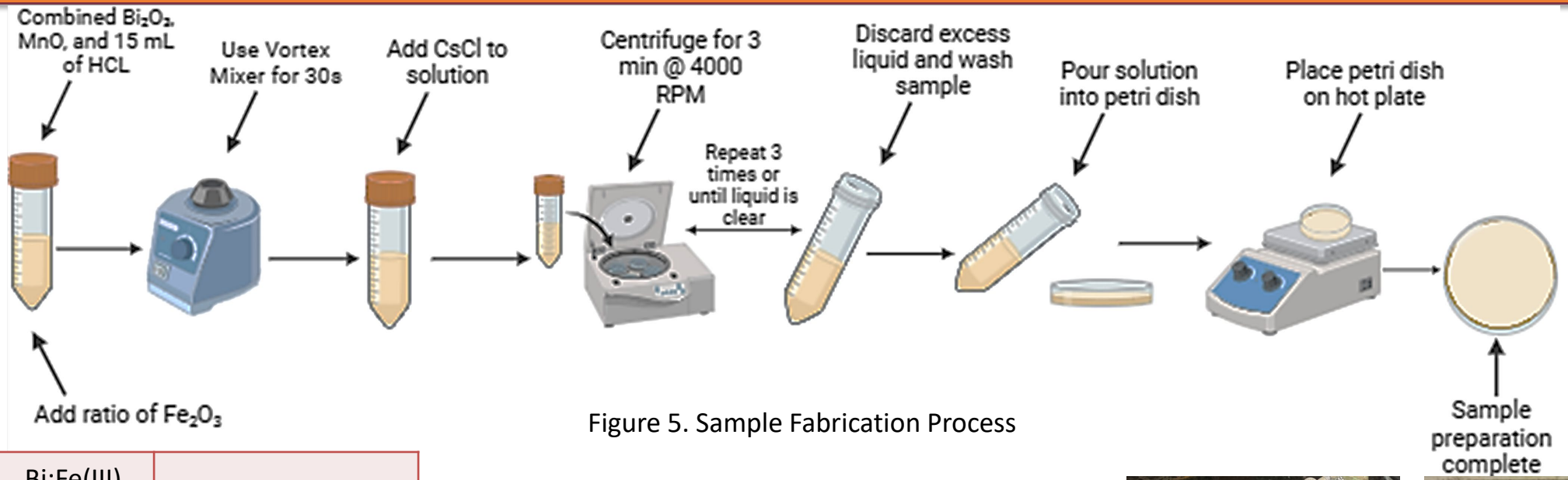

Figure 5. Sample Fabrication Process

Sample #	Bi:Fe(III) Ratio	Measured Fe
1	1:0	0 mg
2	1:0.25	59 mg
3	1:0.50	119.76 mg
4	1:0.75	179 mg
5	1:1	239.53 mg
6	1:1.25	299 mg

Figure 6. Measured Iron amounts

Figure 7. Samples before and after 24 hours on hot plate

Results cont'd

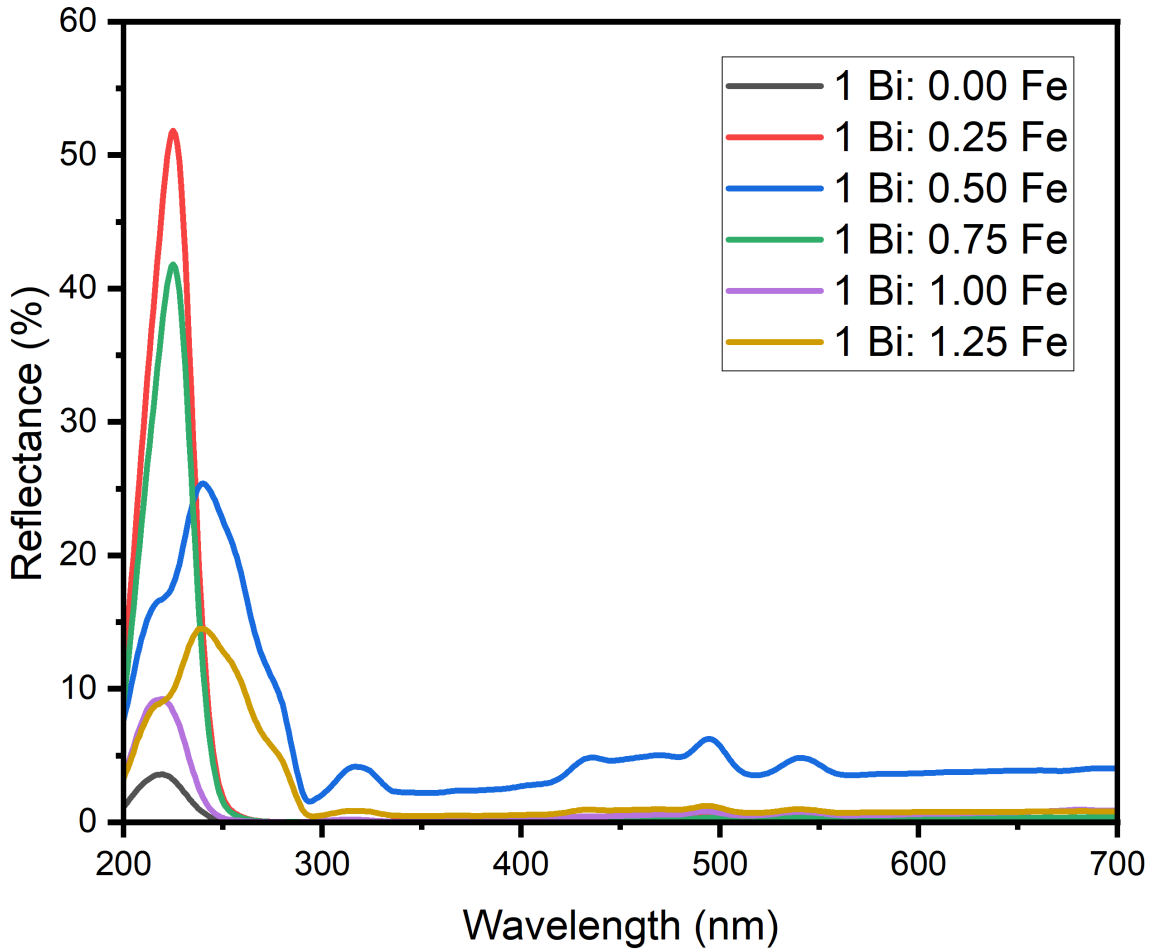

Figure 8. Reflectance Graph

Calculated Bandgaps	
Bi:Fe (III) Ratio	Reflectance (Munk's Value)
1:0.00	2.90 eV
1:0.25	2.94 eV
1:0.50	2.54 eV
1:0.75	2.72 eV
1:1.00	2.69 eV
1:1.25	2.66 eV

Results cont'd

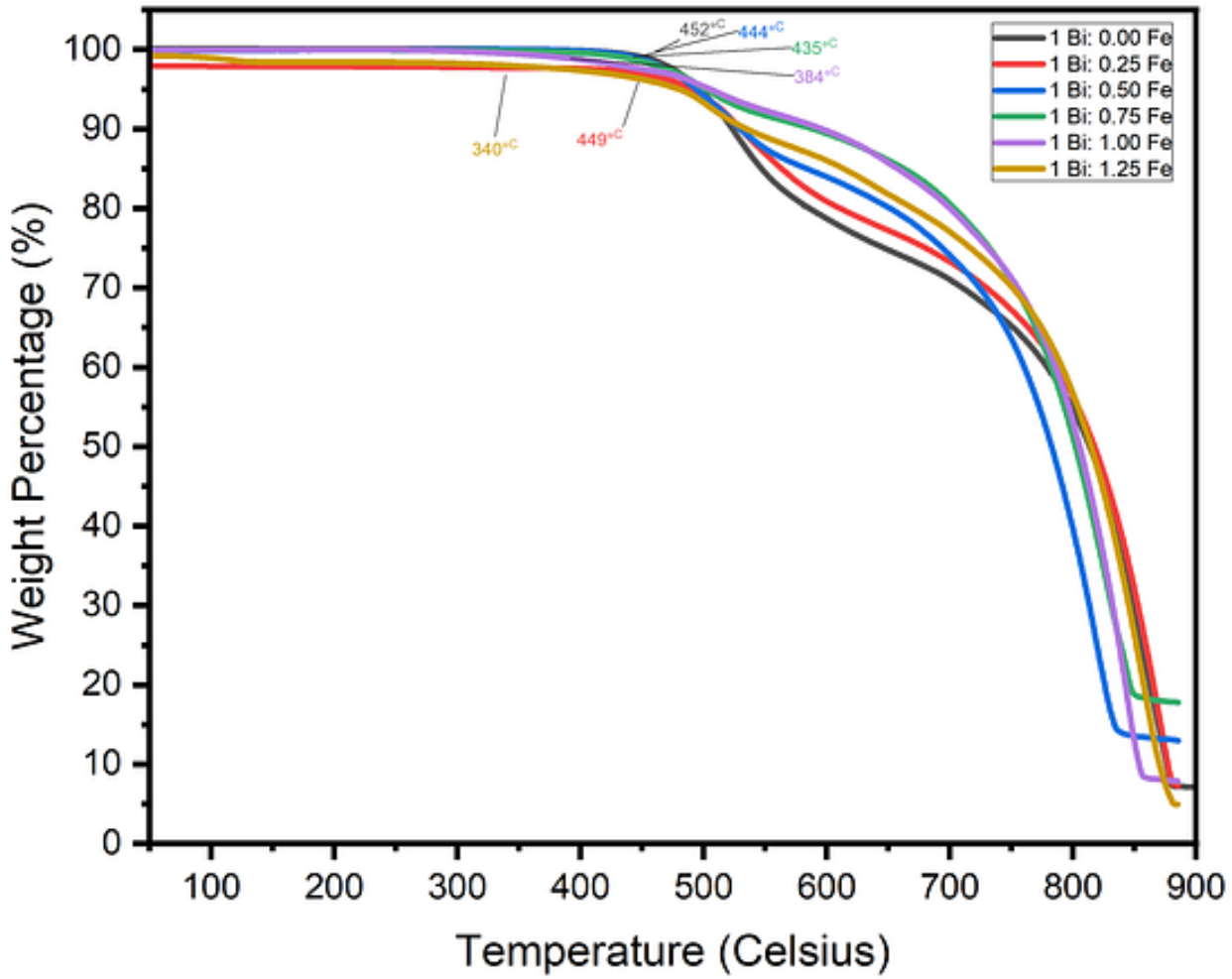

Figure 9. TGA data of samples with varying ratios

Results cont'd

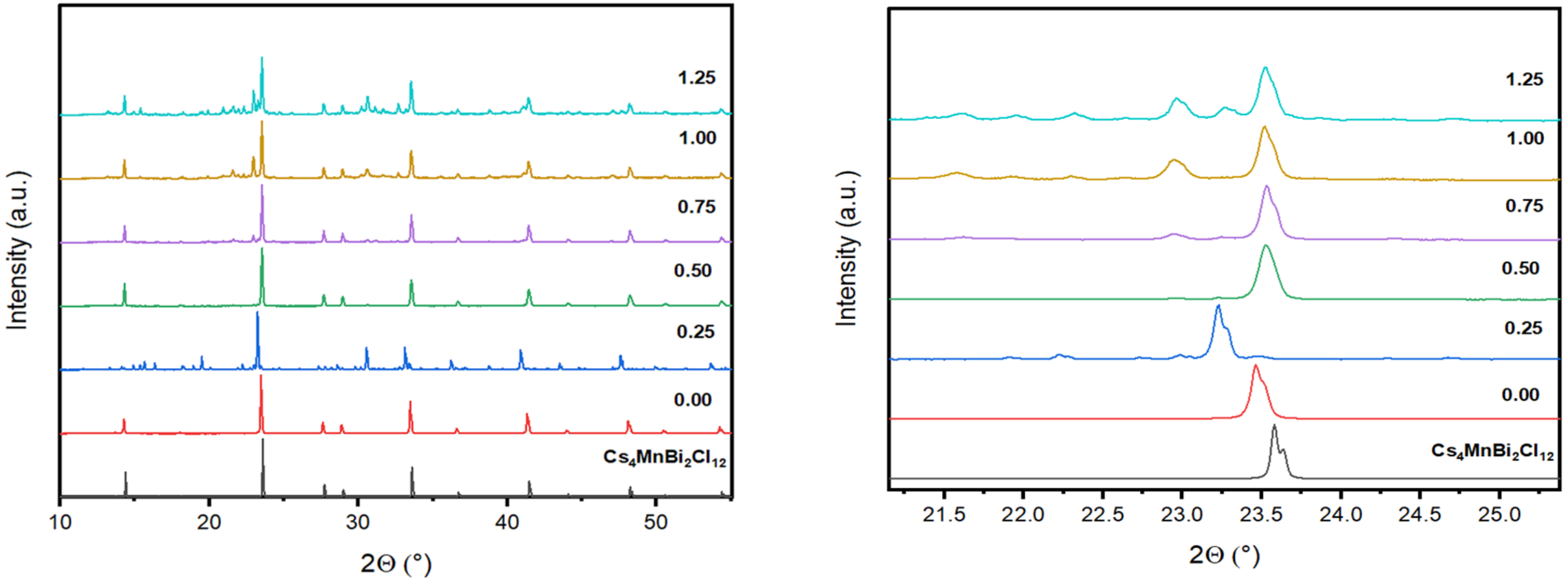

Figure 10. (a) XRD patterns of respective samples, (b) Zoomed in image of largest peaks.

Results cont'd

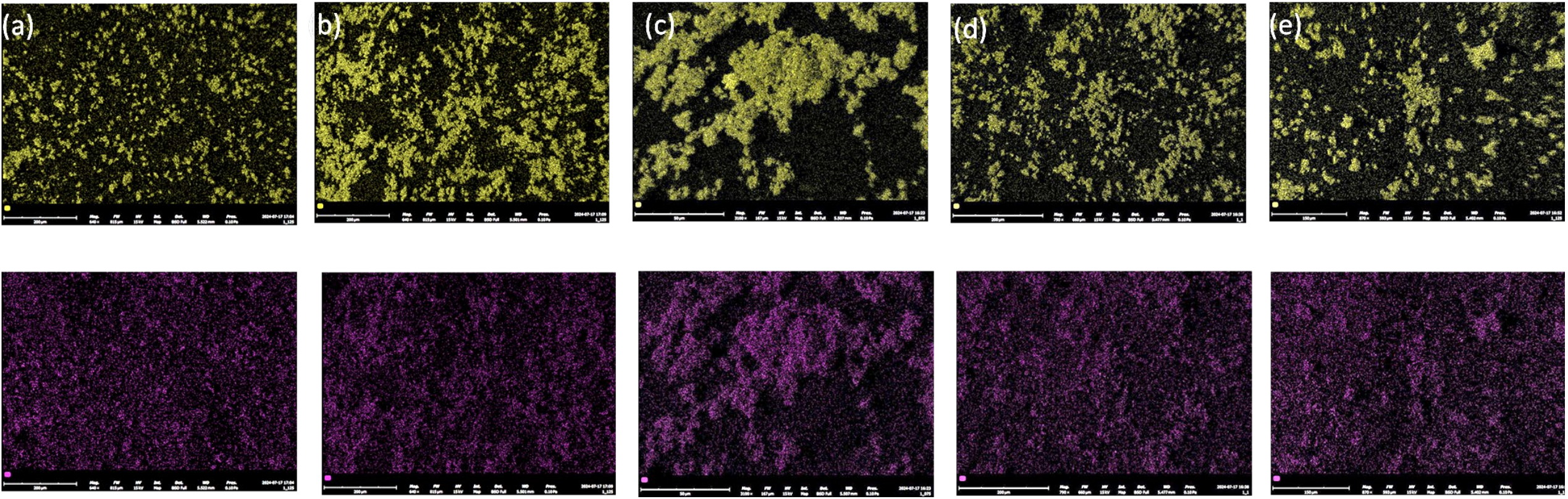

Figure 11. EDS images of Bismuth (yellow), and Iron (pink) of (a) 1:0.25, (b)1:0.50, (c) 1:0.75, (d) 1:1, (e) 1:1.25

Conclusion & Future Work

The XRD graph will confirm the successful doping of the Fe^{+3} into $Cs_4MnBi_2Cl_{12}$.

The peaks shifting correlate to the modification of the crystal structure.

Testing the emission properties of the crystals via the Photoluminescence test.

Improving the humidity and thermal stability of the perovskite through encapsulation via SiO_2 and Oleic Acid

Synthesize single crystal $Cs_4MnBi_2Cl_{12}$ to perform single crystal XRD.

Acknowledgement