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

Janiya Richardson[1], Franchesca Bellevu[2,3], Dr. Amr Elattar[3], Dr. Adrienn Szcus[4], Dr. Tarik Dickens[2,3]
[1]Department of Computer Science, Spelman College, 350 Spelman College SW Ste 927, Atlanta, GA 30314
[2]Department of Industrial & Manufacturing Engineering, Florida A&M University, 1601 S Martin Luther King Jr Blvd, Tallahassee, FL 32307
[3]High-Performance Materials Institute, FAMU-FSU College of Engineering, 2005 Levy Street, Tallahassee, FL 32310
[4]National High Magnetic Field Laboratory 1800 E Paul Dirac Dr, Tallahassee, FL 32310

FAMU-FSU College of Engineering
DEPARTMENT OF INDUSTRIAL & MANUFACTURING ENGINEERING

Introduction

Perovskites are a family of crystalline compounds with a unique crystal structure and can be used as photodetectors.

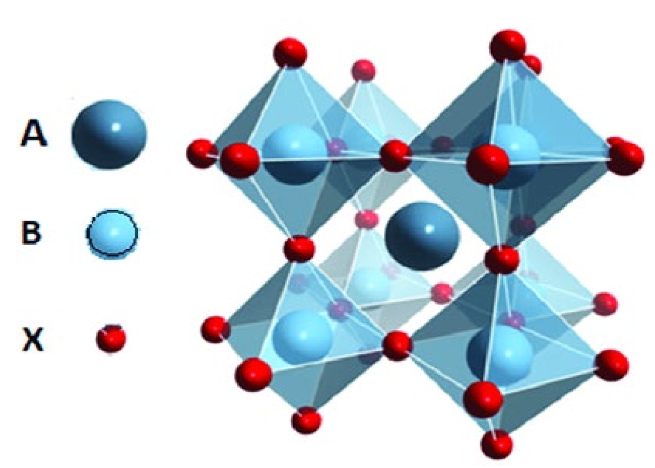

Figure 1. Chemical formula of perovskite
https://www.doria.fi/handle/10024/177684

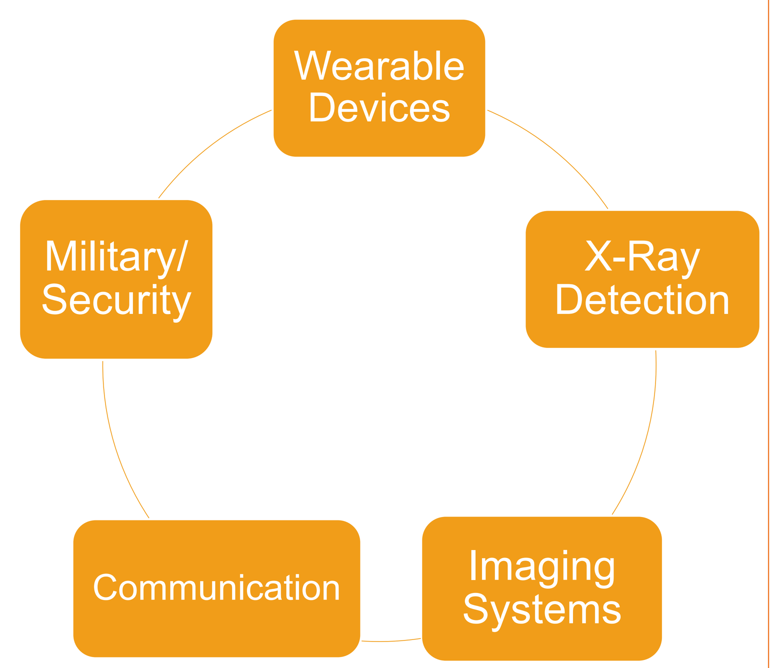

Figure 2. Photodetection Applications

- **Research Objectives**
  - Create designs of experiments to assess the effects of doping on the base perovskite.
  - Fabricate and test the effects of iron addition on microcrystals.
  - Enhance optical properties and reduce the bandgap of crystals.

Experimental Method

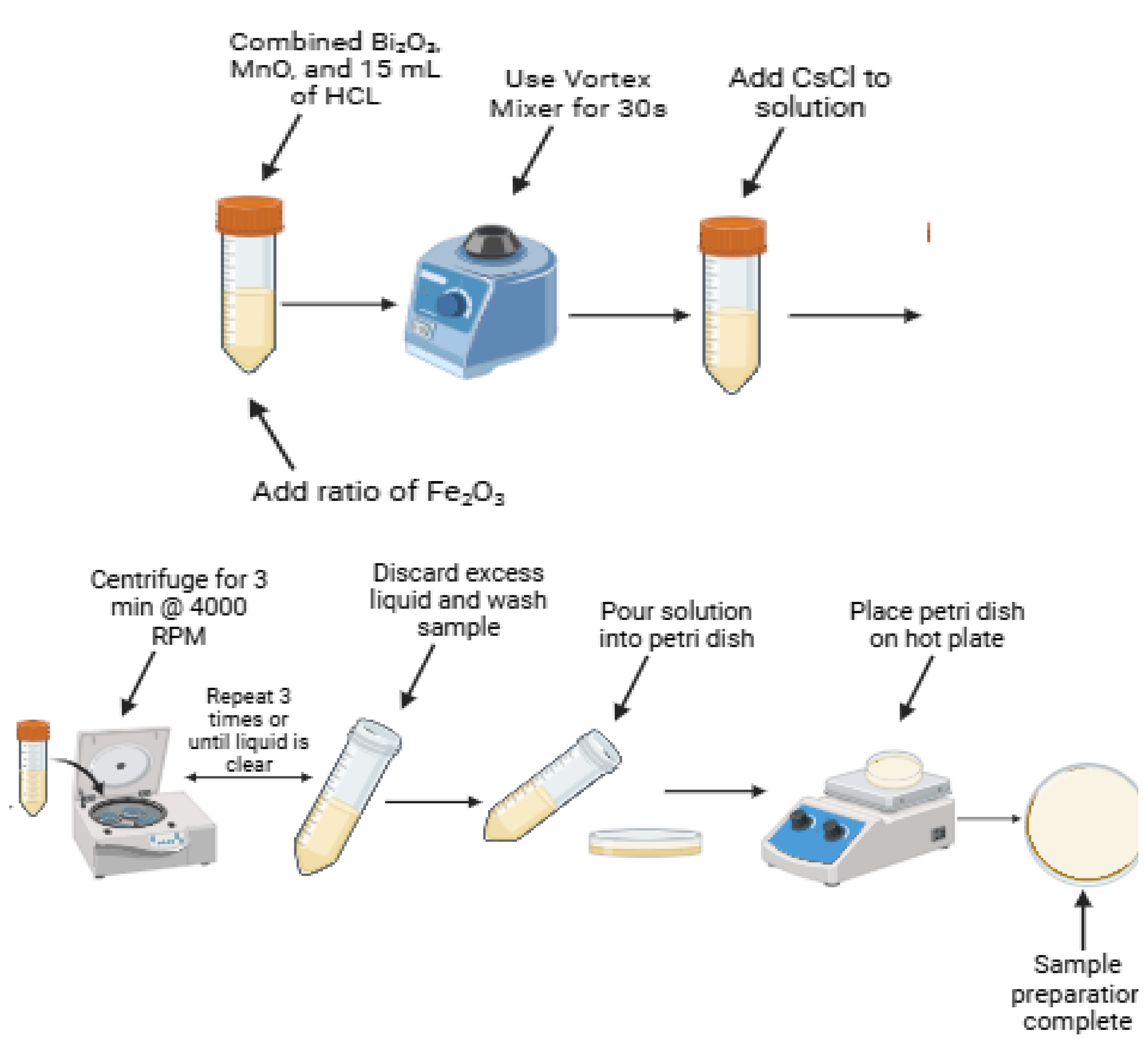

Figure 3. Sample Fabrication Process

Experimental Method Cont'd

Figure 4.Samples before and after 24 hours on hot plate

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 5. Measured Iron amounts

Results & Discussion

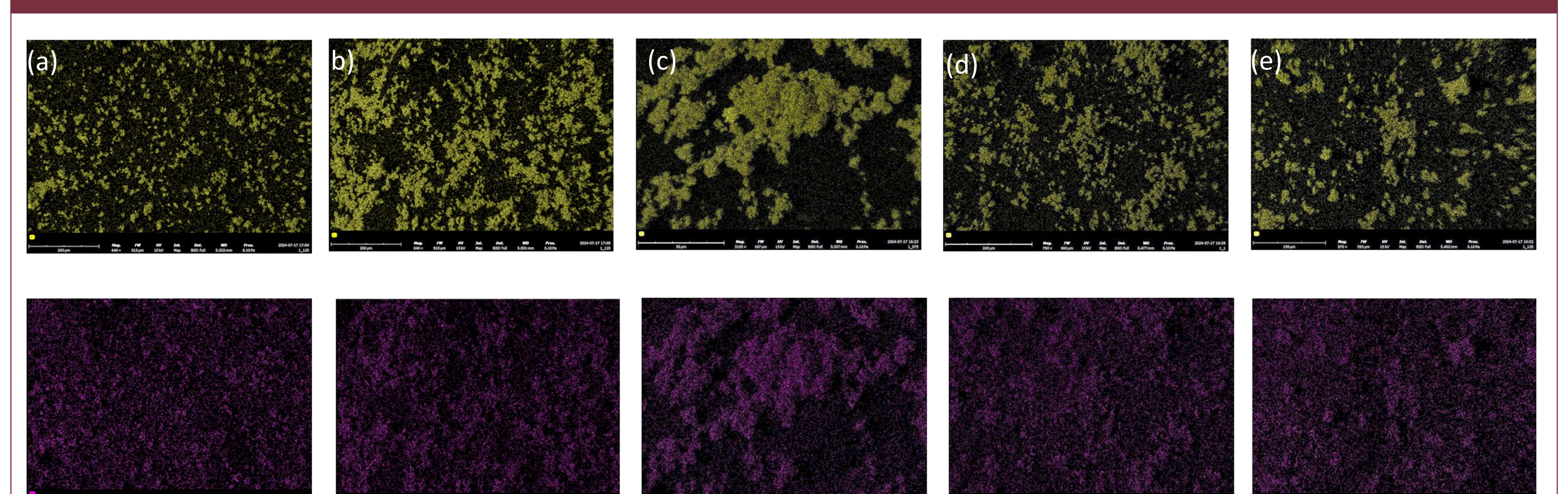

Figure 6: EDS images of Bismuth (yellow), and Iron (pink) of (a) 1:0.25, (b)1:0.50, (c) 1:0.75, (d) 1:1, (e) 1:1.25

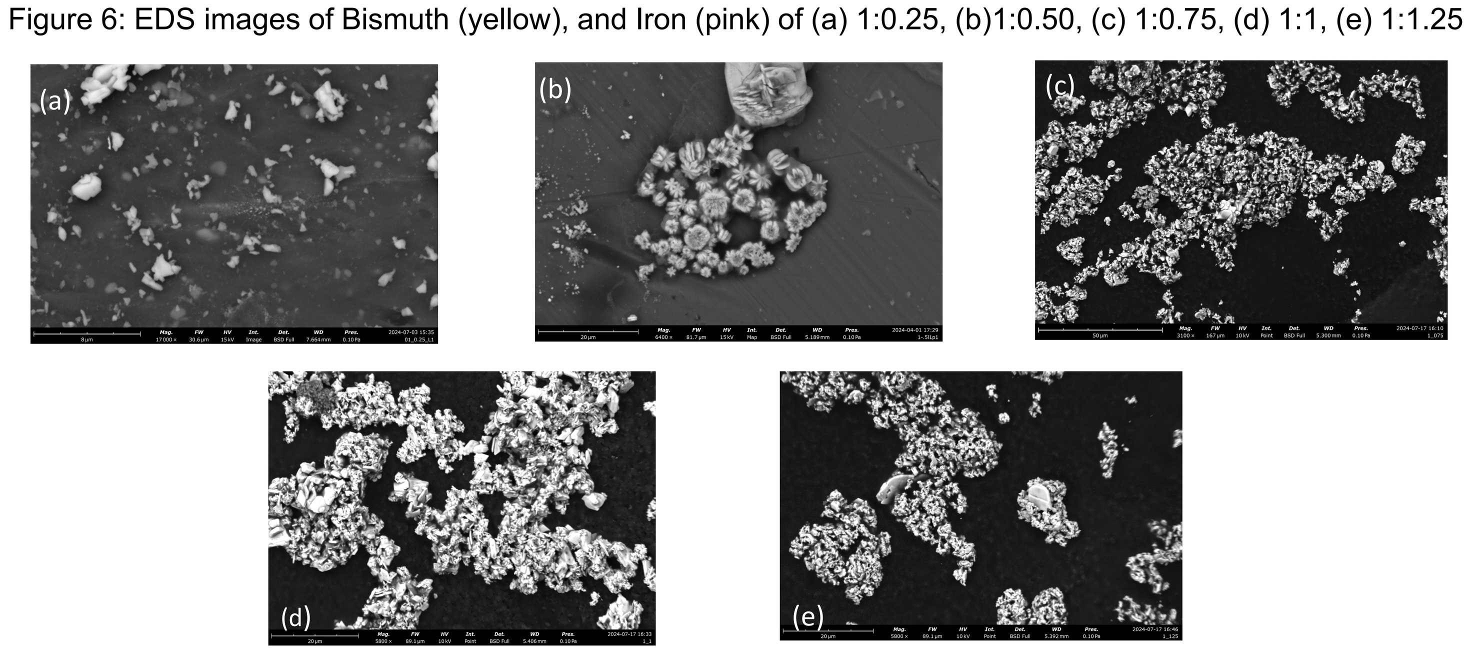

Figure 7: SEM images of (a) 1:0.25, (b) 1:0.50, (c) 1:0.75, (d) 1:1, (e) 1.25

Results & Discussion Cont'd

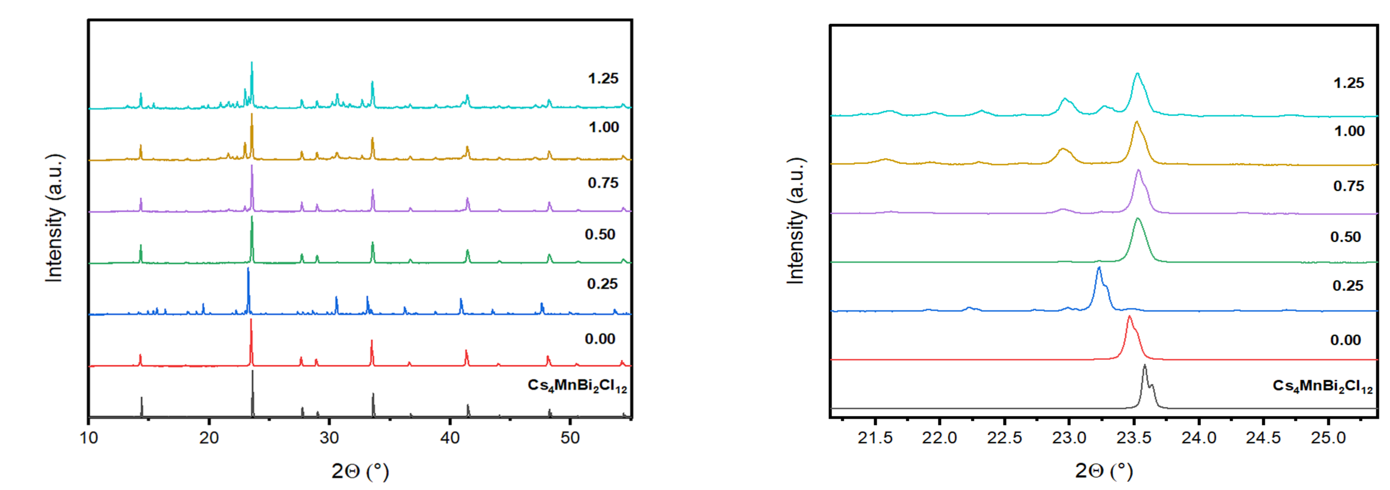

Figure 8. (a) XRD patterns of respective samples, (b) Zoomed in image of largest peaks.

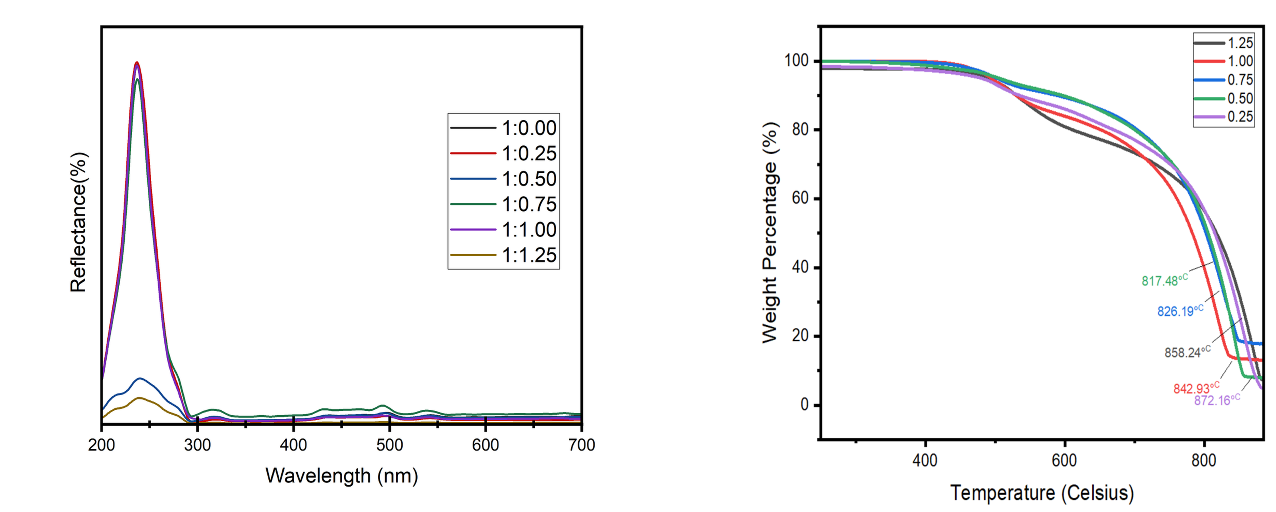

Figure 9. (a) Reflectance data of samples with varying ratios, (b) TGA data of samples with varying ratios

Conclusion & Future Work

1. XRD data shows that peaks have shifted to show contraction in samples.
2. TGA reflects increased thermal stability, and high reflectance found in some, but not all, samples.

Future Work: Test the emission properties of the crystals via the Photoluminescence test. Improve humidity stability of the perovskite through encapsulation.

References

(1) Udavant, R.; et al. Lead-Free Solid State Mechanochemical Synthesis of Cs2NaBi1–xFexCl6 Double Perovskite: Reduces Band Gap and Enhances Optical Properties. Inorg. Chem. 2023, 62 (12), 4861–4871. https://doi.org/10.1021/acs.inorgchem.2c04149.

(2) Wei, J.-H et al. All-Inorganic Lead-Free Heterometallic Cs4MnBi2Cl12 Perovskite Single Crystal with Highly Efficient Orange Emission. Matter 2020, 3 (3), 892–903. https://doi.org/10.1016/j.matt.2020.05.018

Acknowledgments

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RESEARCH EXPERIENCES FOR UNDERGRADUATES

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

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