

ZnO-Based Alloys with By-Design Optical Properties

Leah Bergman and Matt McCluskey* DMR-1202532

Professor of Physics, University of Idaho, *Professor of Physics, Washington State University

Primary Research Interest

Realization of ZnO-based alloys with by-design optical properties in the blue to the UV part of the spectrum. Two alloy systems are being achieved and researched: $\text{Mg}_x\text{Zn}_{1-x}\text{O}$, that enables tunability to the deep UV range: $\sim 3.3 - 6$ eV (376 - 207 nm), and $\text{ZnS}_x\text{O}_{1-x}$ that enables tunability to the blue/visible range: $\sim 3.3 - 2.6$ eV (376 - 477 nm). The alloys are thin films grown via a magnetron sputtering technique and have granular morphology.

Challenges to overcome

I. $\text{Mg}_x\text{Zn}_{1-x}\text{O}$: Challenge: Overcoming the inherent phase segregation tendency, reduction of intrinsic defects, and enhancement of the UV luminescence. **Approach:** Annealing under an Argon environment was found to significantly improve the material and optical properties due to the removal of the intrinsic defects.

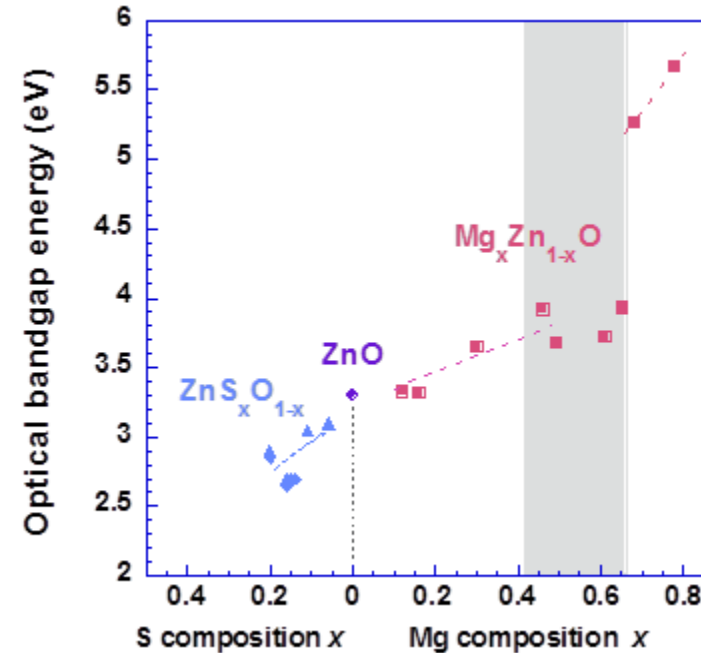
II. $\text{ZnS}_x\text{O}_{1-x}$: Challenge: This system should exhibit a phase segregation, and in addition has energetically favorable intermediate phases such as zinc sulfate ZnSO_4 which impacts material and optical properties. **Approach:** ZnSO_4 formation is highly-sensitive to both temperature and pressure. We are exploring growth and annealing conditions to suppress this phase.

Primary Broader Impact Activity

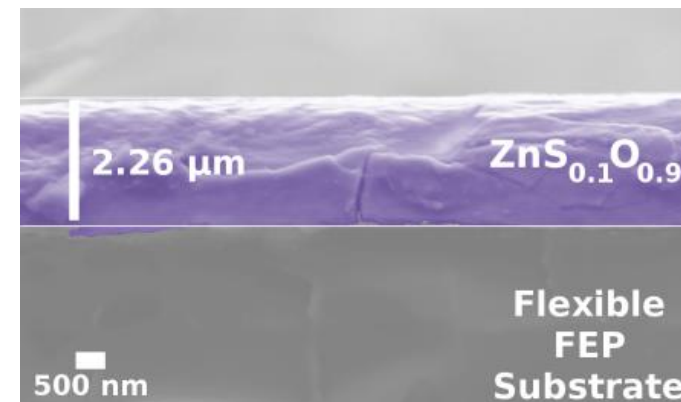
- Creating relatively environmentally-friendly material systems via a sputtering technique which is a cost-effective growth method.
- The alloys can be used in lighting and optoelectronic technologies that require tailored optical properties with a large wavelength ranging from the blue to the deep UV. Potential applications include new-generation light sources and sensors.
- Disseminating lectures to the general public and young students on topics of materials science in consumer technology. A movie on the basics of LED is available online at <http://lbergmanuidaho.wordpress.com/presentations/>

Interests in New Collaborations

Fostering interaction with researchers in the field of semiconductor alloys.



The optical gap of the alloys as a function of composition, x.



Cross section SEM image of one of the alloys