Installation, calibration, and experimental verification of a layered deposition scheme

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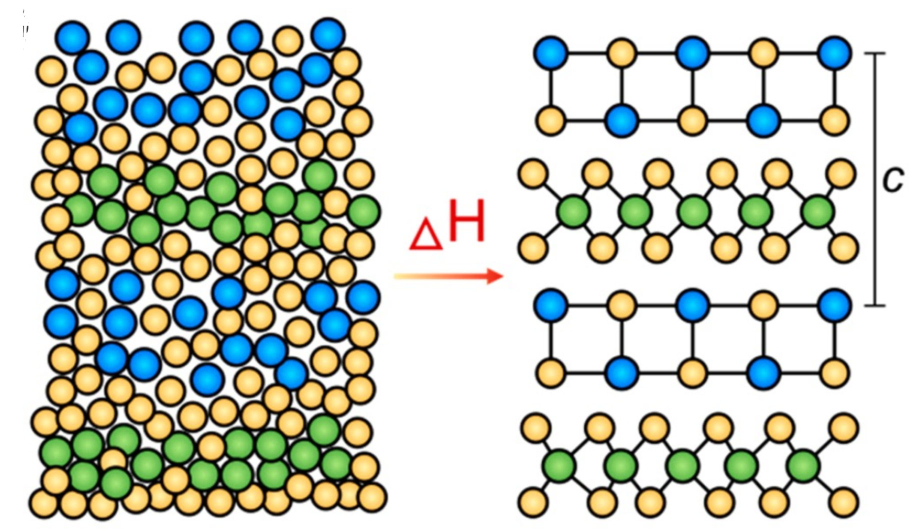
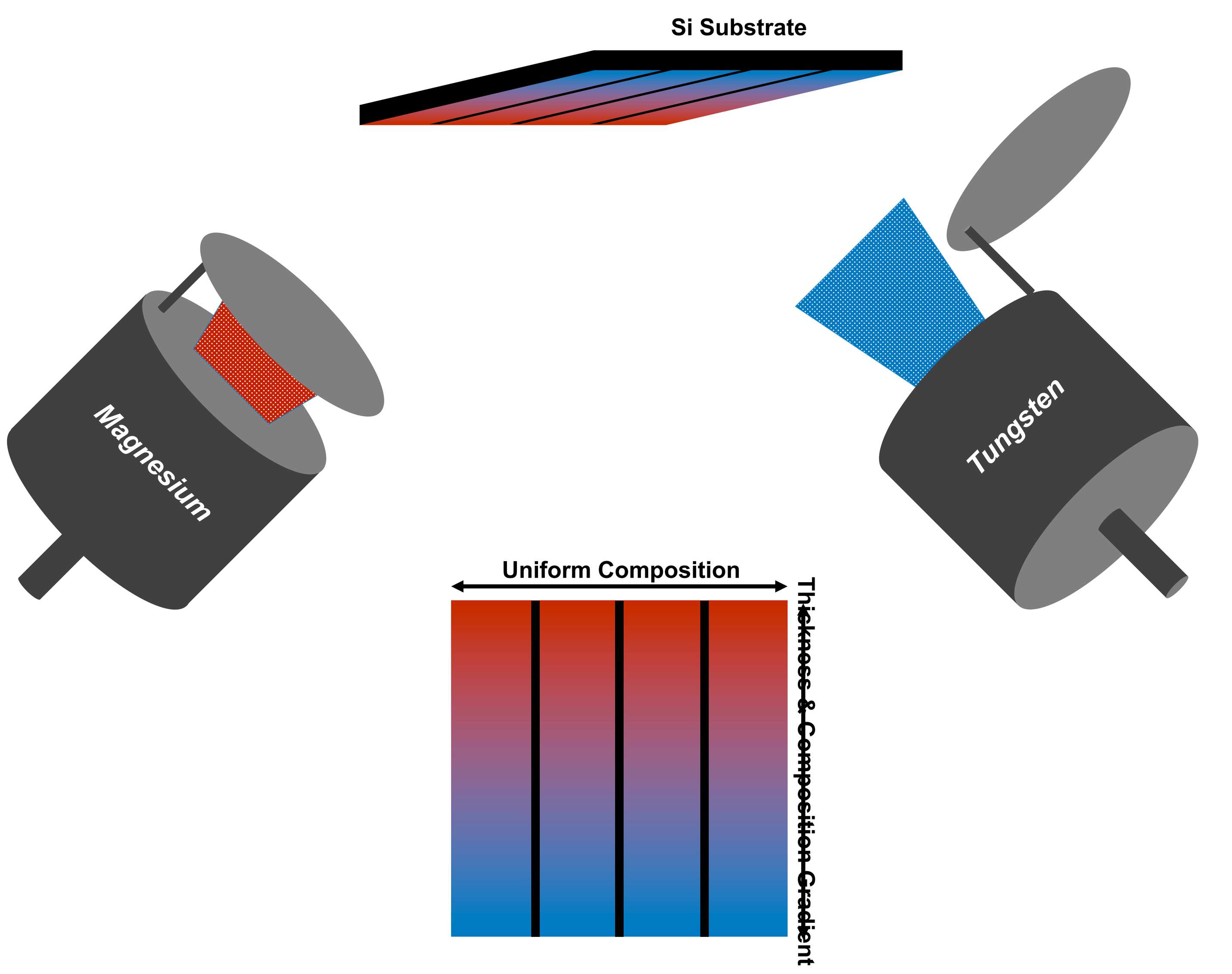
Introduction and Motivation

- **Layered material deposition allows for the synthesis of previously undiscovered materials**
- **Depositing materials in amorphous layers at ambient temperature has been shown to facilitate reordering under annealing conditions**
  - **Prior research in chalcogenides (SnS and TaS_2) at NREL [1,2]**
    - **Our goal is to expand this research to new materials, particularly nitrides [3]**
- **Exploring the viability of using high-vacuum magnetron sputtering to produce other novel nanoscale layered materials**

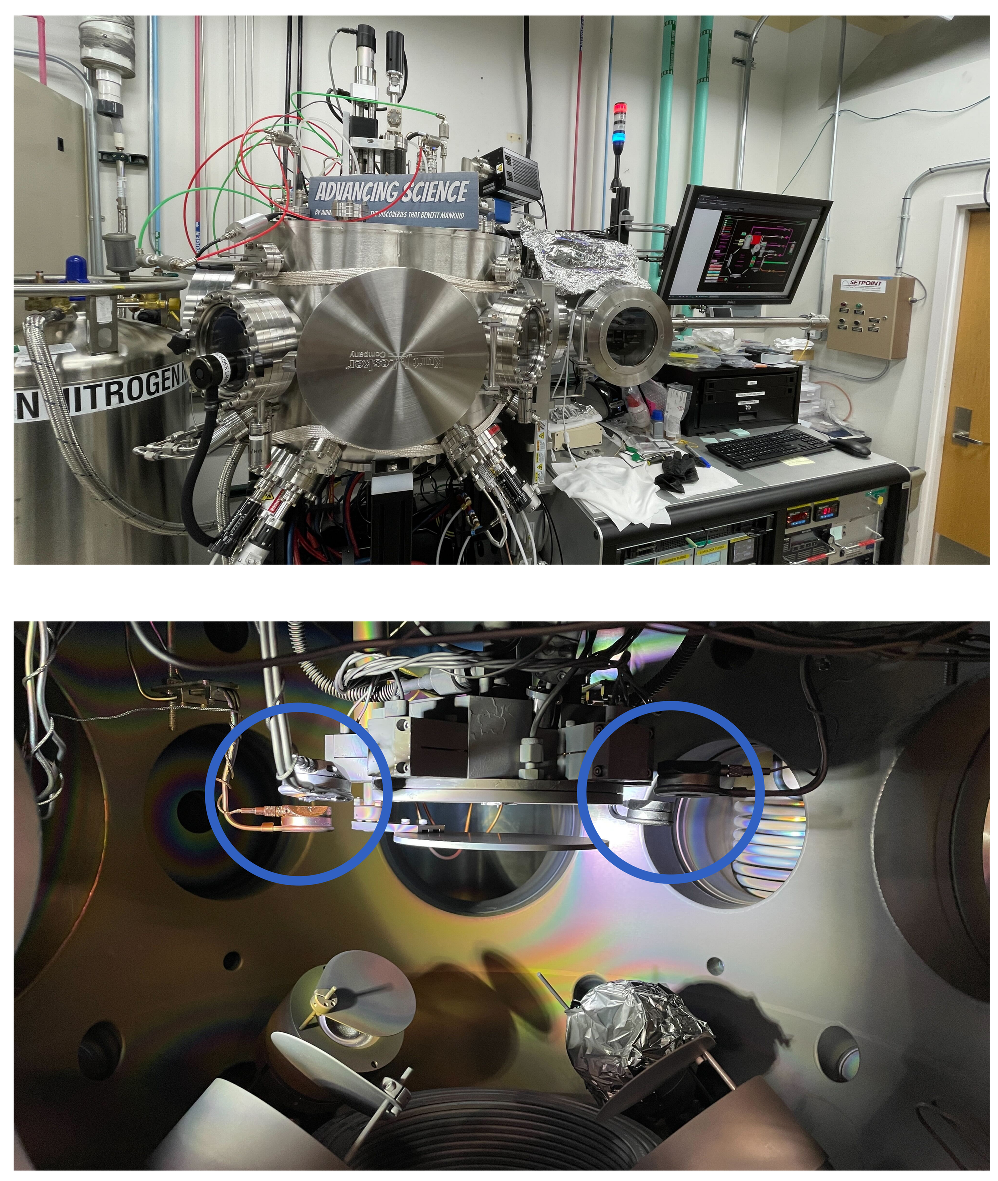


Amorphous material deposition reordering into a layered pattern under anneal. Figure from Ref. 2

Sputtering Chamber Overview



Representation of sputter deposition setup with compositional gradient and substrate masking shown



Exterior and interior of Combi 9 sputtering chamber. Note QCMs circled in blue

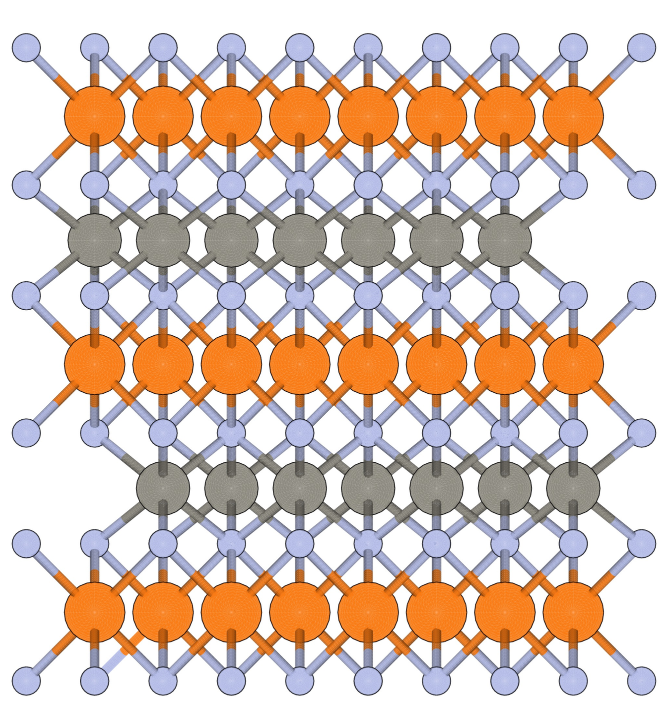
Sensor Installation

- **Quartz crystal monitors (QCMs) installed above each sputtering gun, adjacent to substrate**
- **Water cooling lines run in parallel to each sensor to allow for high-temperature growths without compromising sensor integrity**

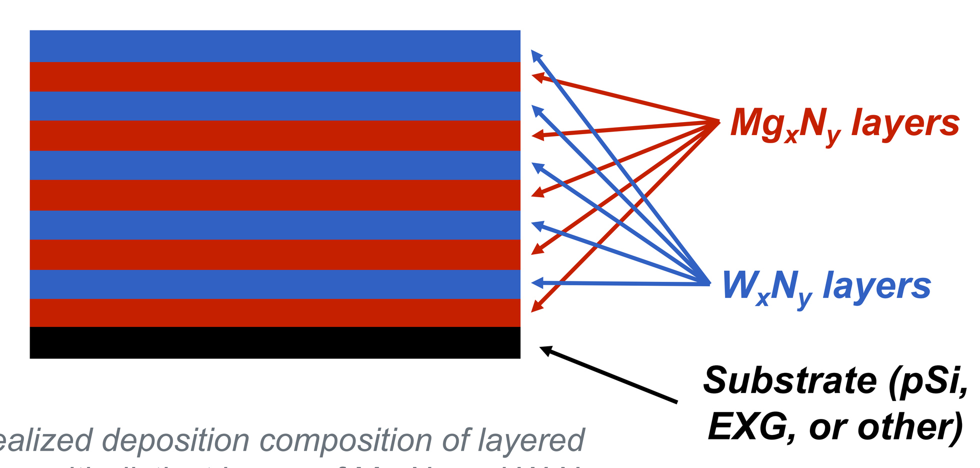
Sensor Calibration

- **Several films of Mg_xN_y and W_xN_y produced under identical growth conditions**
- **Thickness determined by using Dektak8 profilometer and averaging across all films**
- **Film density, z-ratio, and tooling factor adjusted to ensure agreement between QCM thickness and measured thickness**

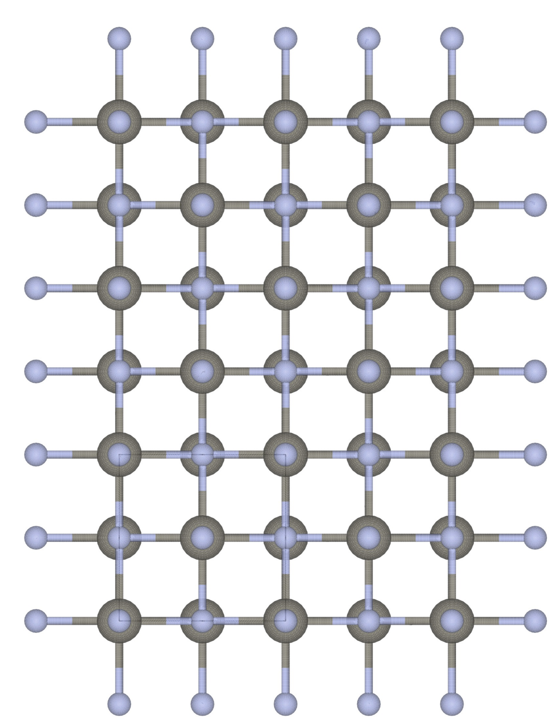
Testing Layered Growths with $MgWN_2$



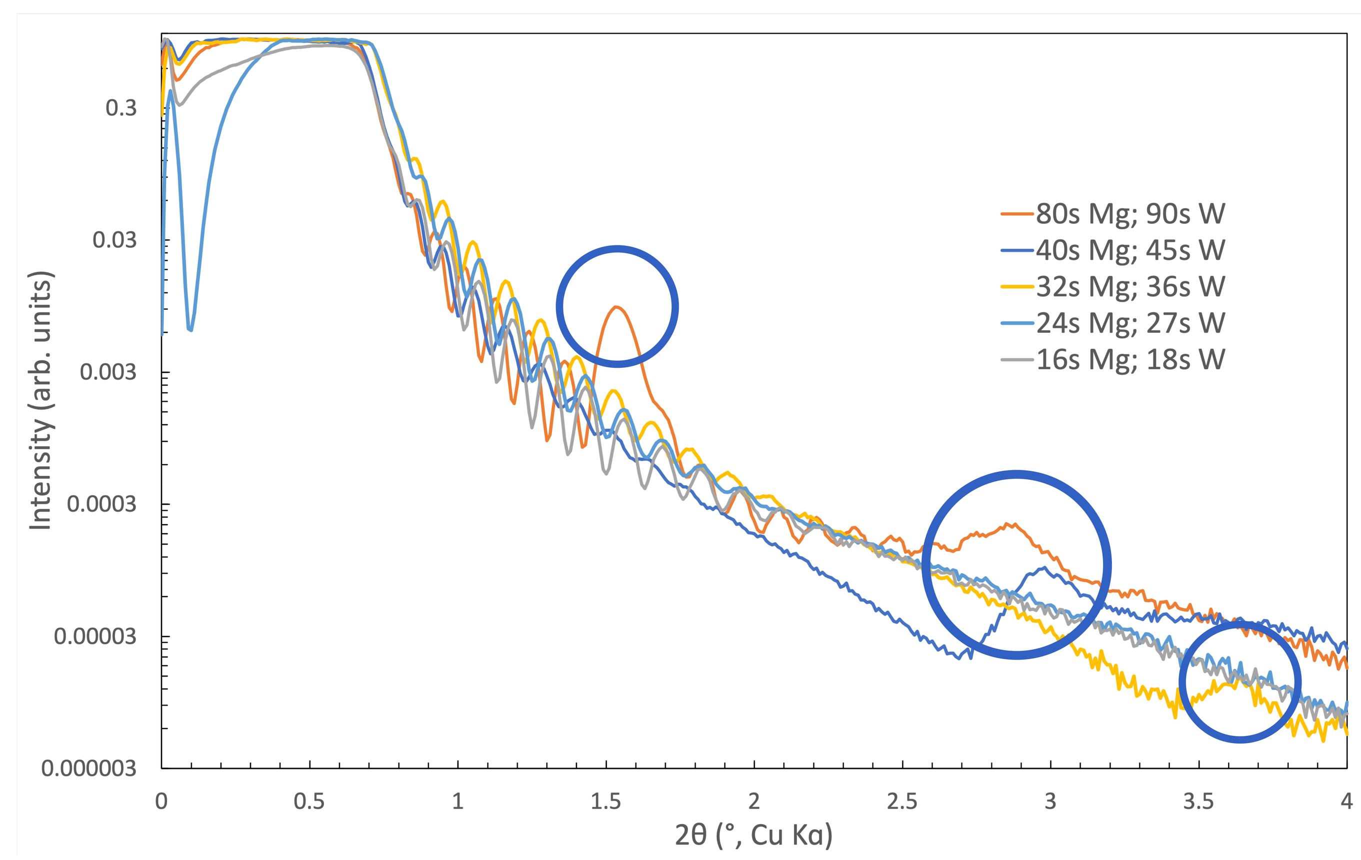
Rocksaline crystal structure, created in VESTA modeling software [4]



Idealized deposition composition of layered films, with distinct layers of Mg_xN_y and W_xN_y



Rocksalt crystal structure, created in VESTA modeling software [4]



X-ray reflectometry (XRR) data of numerous layered growths

Conclusions

- **XRR data revealed that layering was present, though not at the desired layer thicknesses**
- **Future research will explore varying deposition conditions to increase likelihood of successful superstructure formation of $MgWN_2$ and other novel nitrides**
  - **Substrate temperature (employing a liquid N_2 substrate cooling system)**
  - **Gun power**
  - **Chamber pressure**

Acknowledgements

I would like to thank my mentor, Rebecca Smaha, for providing me with patience and guidance as I worked through this project. I would also like to thank Davi Febba, whose help with the sputtering chamber was indispensable to the success of my project. Lastly I would ilke to thank Sage Bauers, Dennice Roberts, and Andriy Zakutayev who provided support with data acquisition as well as helping me choose a direction for my research.

References

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This work was supported, in part, by the U.S. Department of Energy, Office of Science, Office of Workforce Development for Teachers and Scientists (WDTS) under the Science Undergraduate Laboratory Internship (SULI) program.