MRL Research Internship

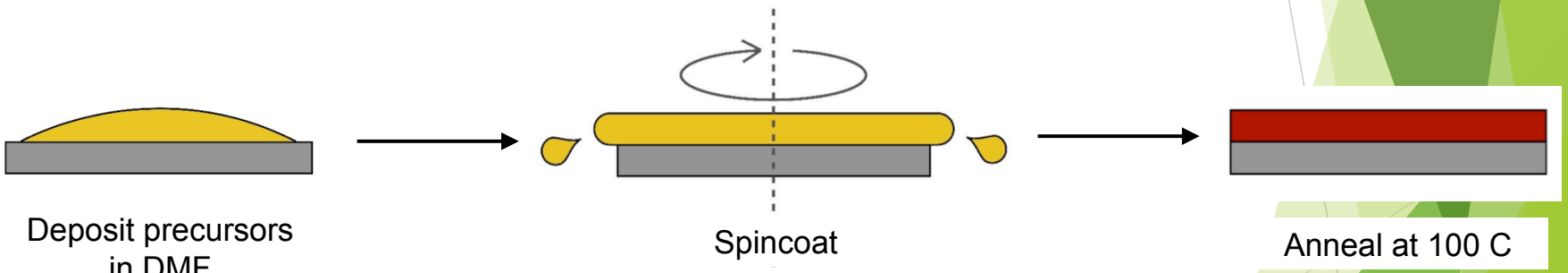
(6 weeks of fun)

Mark Larsen

Malibu High School

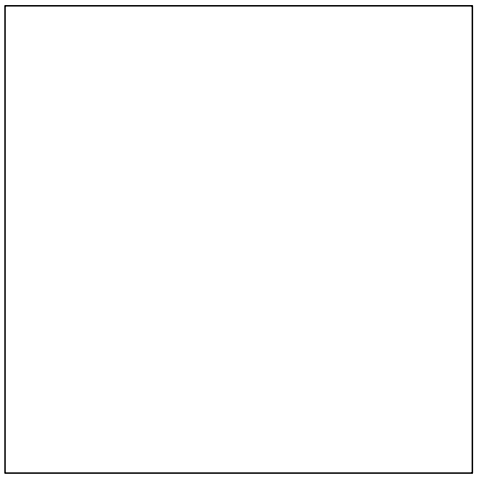
Film growth from solution forms large grains

$2C_8H_{17}NH_3I + (n-1)\,CH_3NH_3I + nPbI_2 \rightarrow (C_8H_{17}NH_3)_2\,(CH_3NH_3)_{n-1}Pb_nI_{3n+1}$



XRD

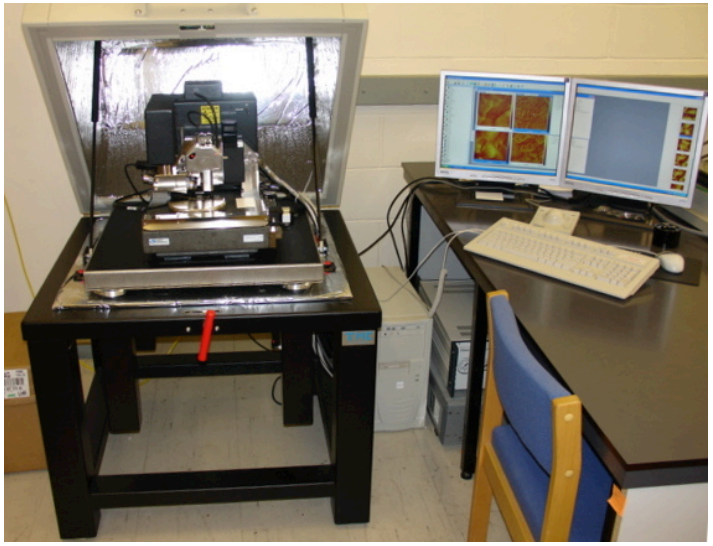
Determines atomic structure of materials and orientation of material with respect to substrate. Important in both confirming the structure of a material and determining if orientation is conducive to charge transfer in a device.

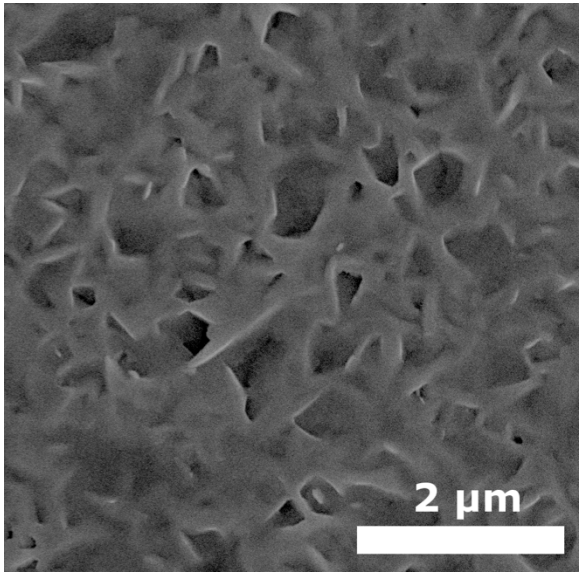


- XRD shows that the perovskite layers tilt more as the layers get thicker.
- Comparing n = 3 to n = 4 shows that they are different and confirms the differing structures

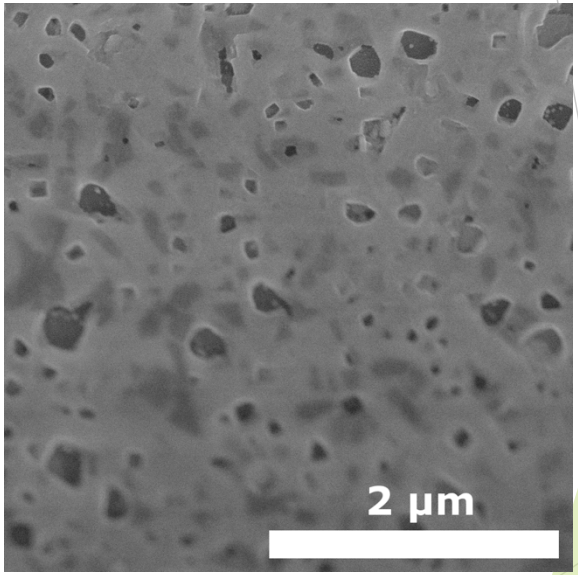
Microscopy-Electron Microscope Atomic Force Microscope

Find physical structure of the film (grain sizes). Important since useful devices required films that are continuous and free of pinholes.





N = 3

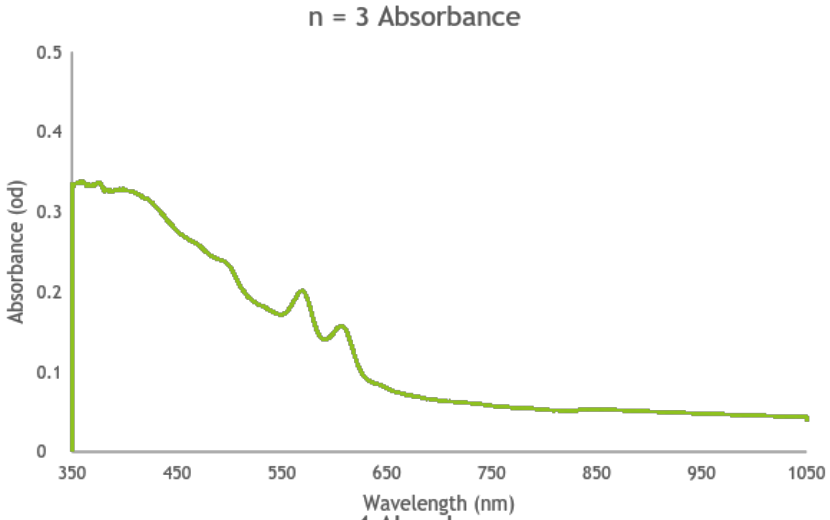


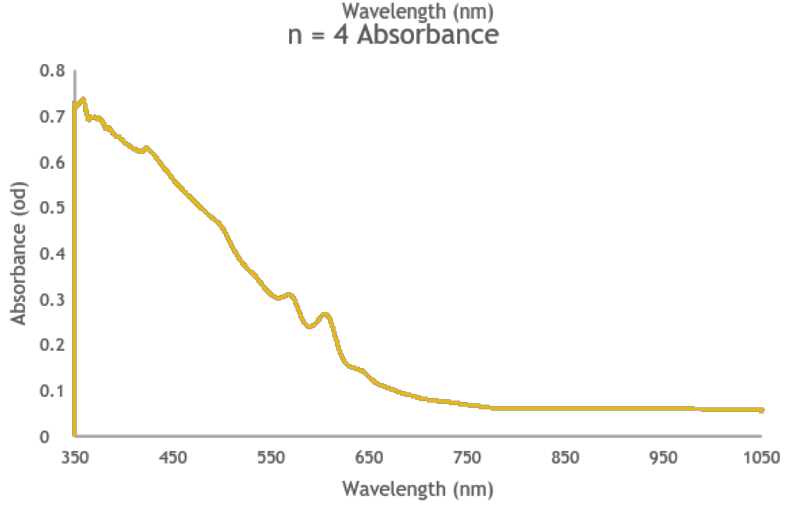
N = 4

- Our process doesn't provide an even coating, but this doesn't affect our measurements.

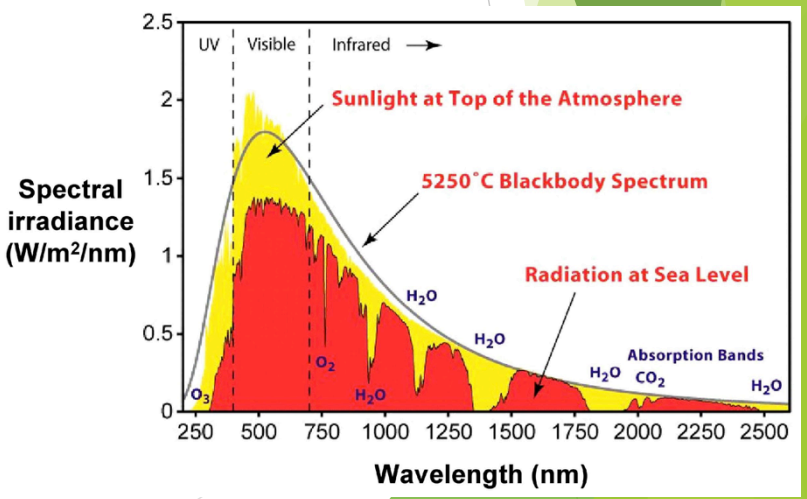
Absorbance

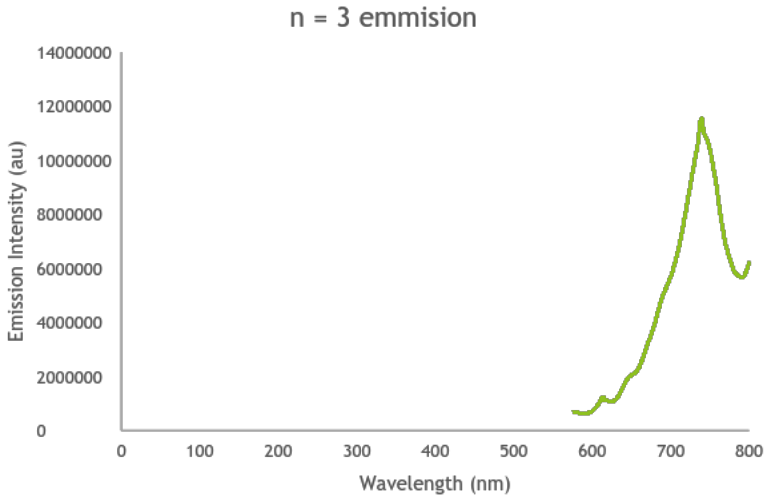
Since these materials are ultimately of interest for solar applications, the absorbance is very important since it determines how well we match up with the solar spectrum.

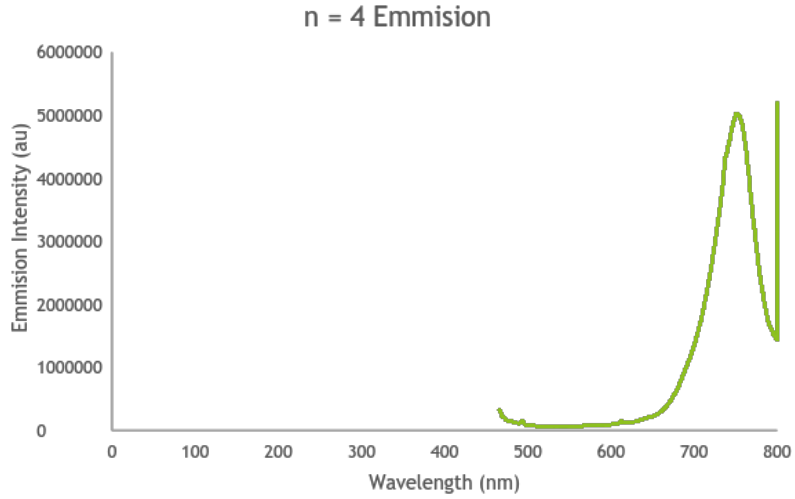




This shows how well this absorbs as a function of wavelength.



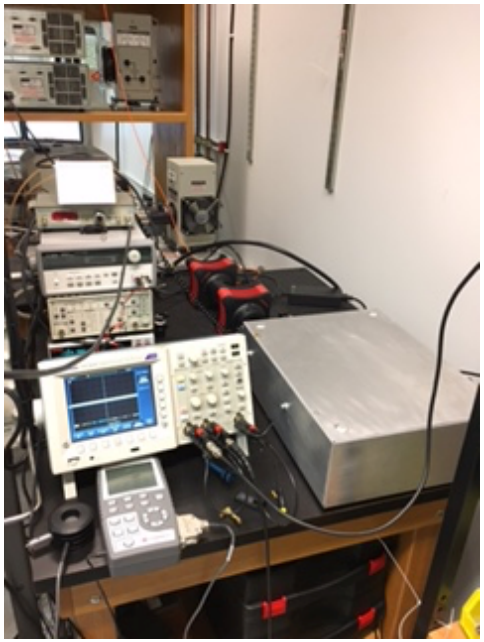


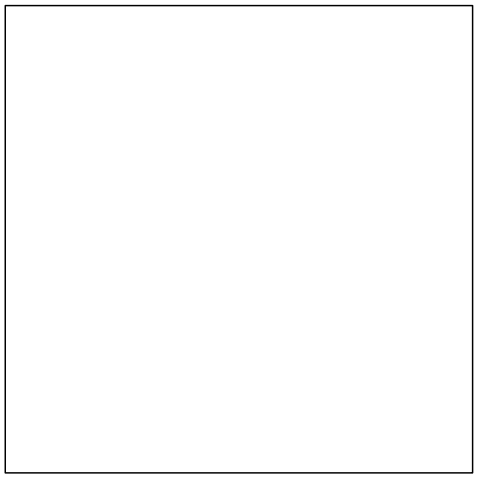


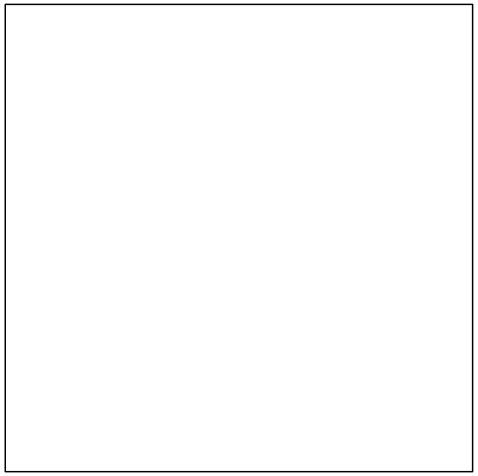
- Emission is a way of assessing material purity.
- If you saw a bunch of strong peaks it would mean you have multiple phases that are emitting.

Time Resolved Microwave Conductivity

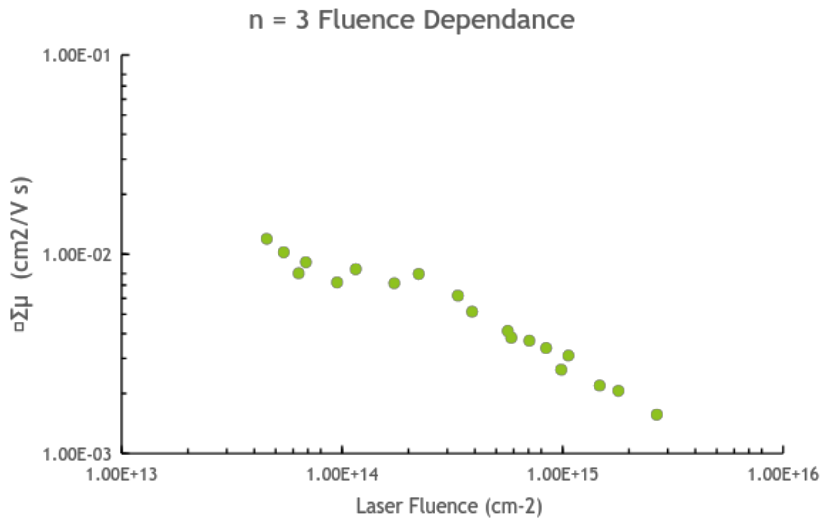
Is a way of directly measuring how well charges move in a material (mobility) which is an important figure of merit for a solar cell material. There is always a trade-off between film thickness and charge extraction since a thicker film often leads to better absorption but if charges do not move easily, they will recombine and be lost before they can be extracted.

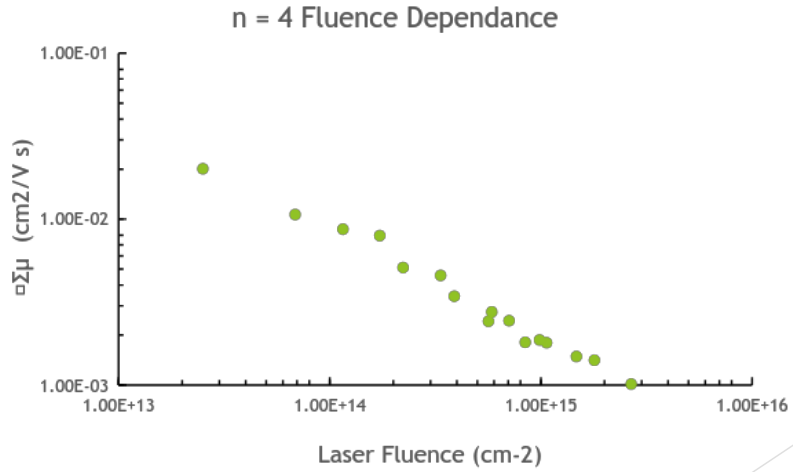






- Data seem to suggest similar mobilities in both compounds regardless of orientation
- Possible long-range charge transport in all directions – potentially leading to highly stable devices





- Both graphs show mobility as a function of the laser power used

Acknowledgements

Chabinyc Group

Special thanks to this amazing group for allowing me to work with them this summer. Their unending patience for my many questions and for welcoming me into their work space. Special thanks to Naveen for letting me witness just a little of his brilliance. The world will be a better place with what he will discover.