# $Pb_2Ir_2O_7$ Thin Film Growth for Spin Transport

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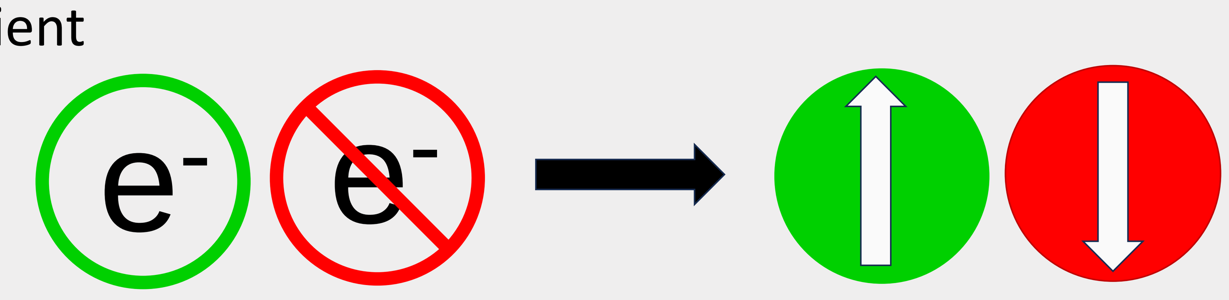
## Background/Motivation

Spintronics

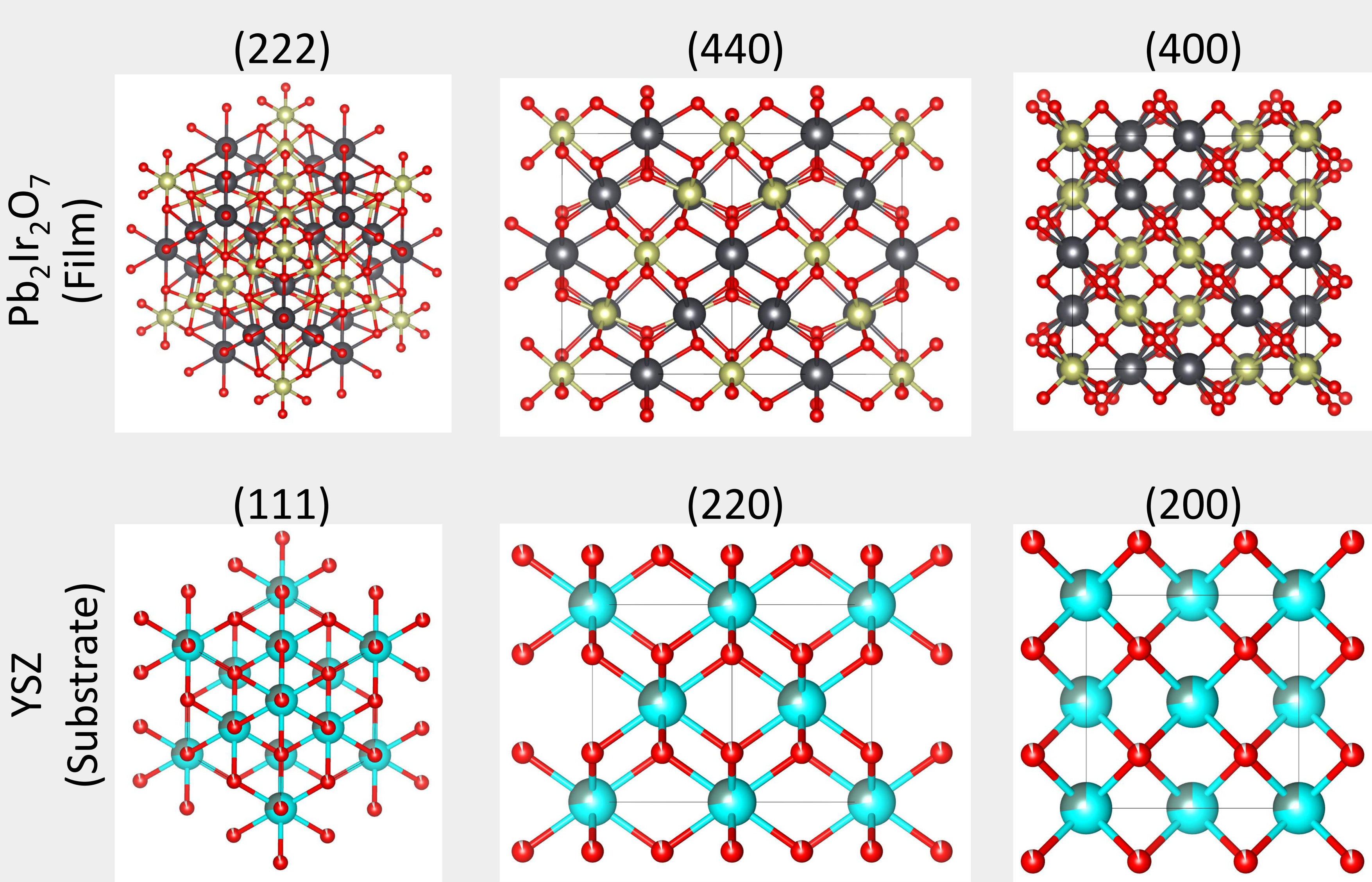
- Replaces absence/presence of electrons with spin states electrons
- More energy efficient
- Faster devices
- Smaller devices



$Pb_2Ir_2O_7$ on YSZ

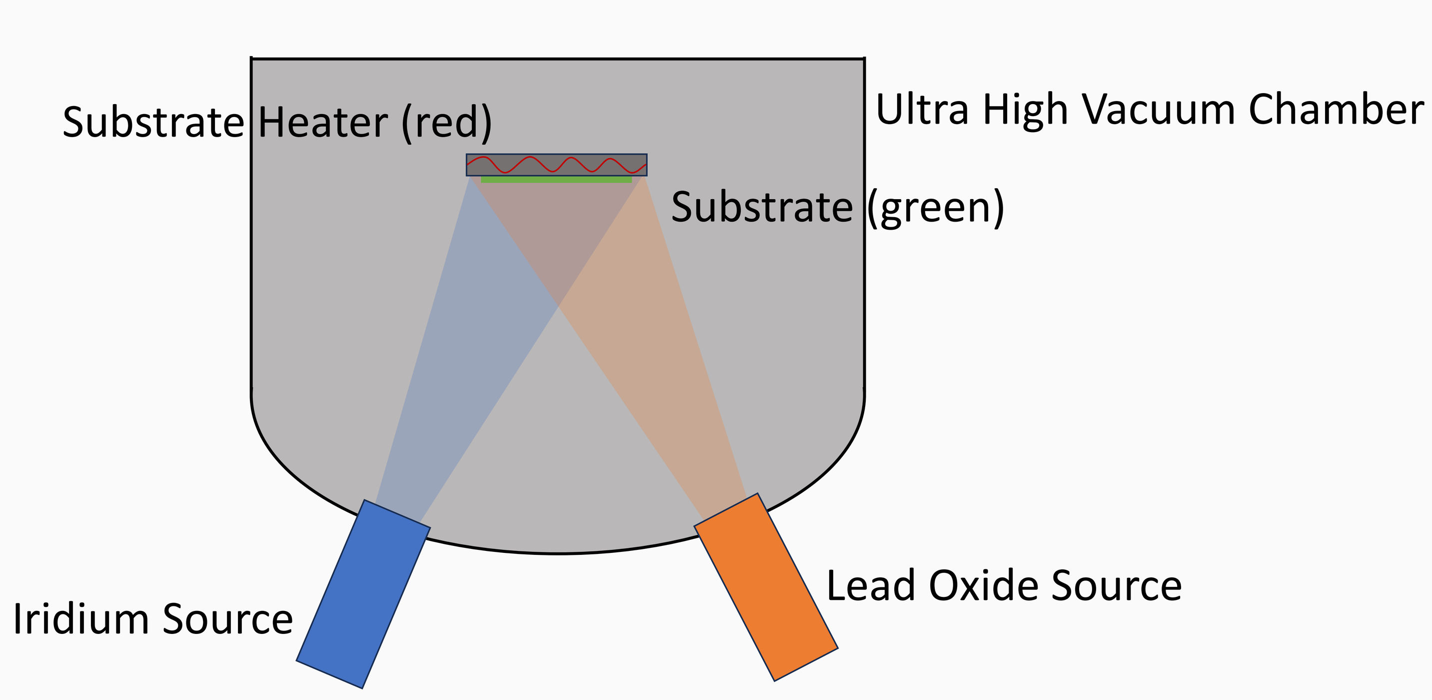
- Iridium has many unpaired electrons resulting in large amounts of spin torque
- $Pb_2Ir_2O_7$ and YSZ are both defect Fluorites
  → Close lattice match
- Most spin transport is done on highly asymmetric crystals
  → $Pb_2Ir_2O_7$ is cubic, so it is highly symmetric
- Different orientations may yield different spin torque

**GOAL: Grow stoichiometric $Pb_2Ir_2O_7$ {111}, {110}, and {100} for spin transport**



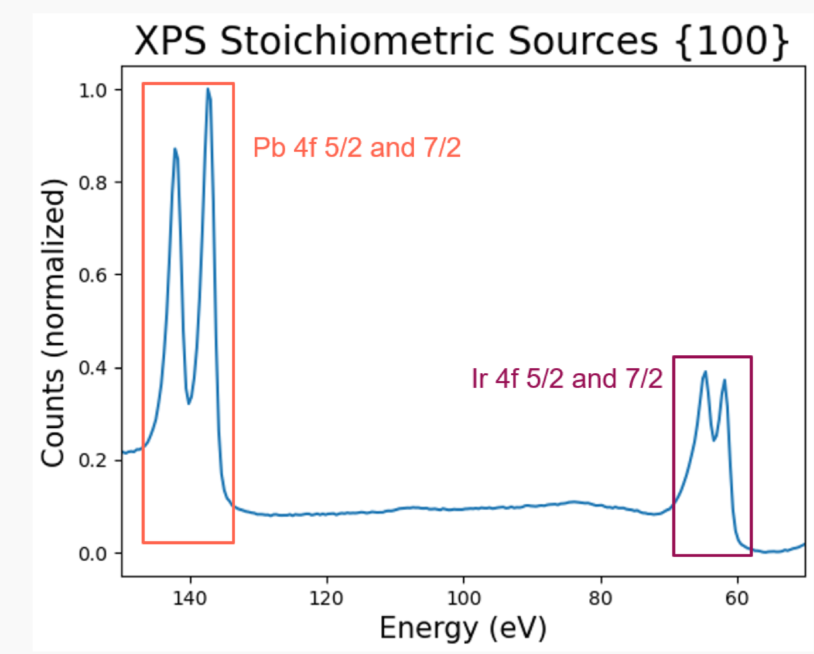

## Growth Method: Molecular Beam Epitaxy (MBE)

- By heating metal sources to high temperatures, MBE creates a beam of cations aimed at the substrate
- The cations arrange on the substrate creating a high-quality thin film
- We used elemental iridium and lead oxide as sources
- Distilled ozone was our oxidation source
- Substrate temperatures was 400°C



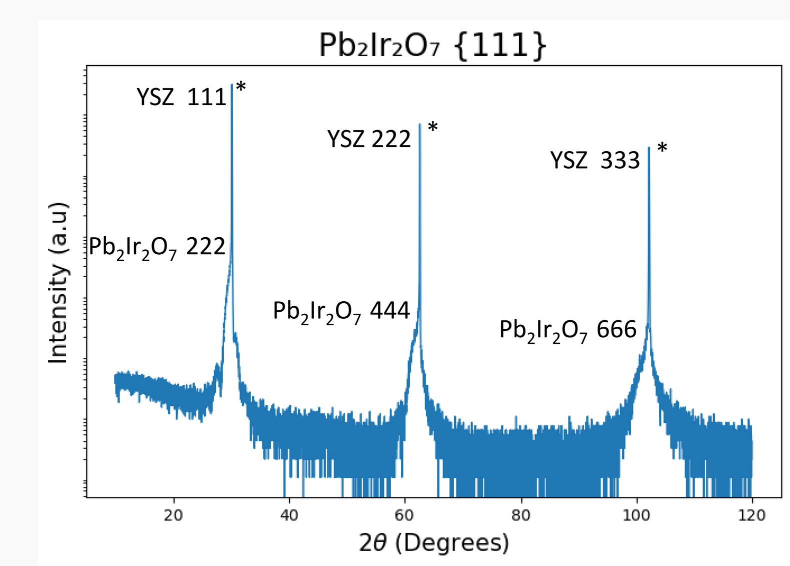

## X-Ray Photoelectric Spectroscopy: Atomic Makeup

- We can calculate the ratio of Pb to Ir using the characteristic energies from electrons by finding the area under the peaks and multiplying it by the relative sensitivity factor
- Using this method, we found our samples **are stoichiometric**

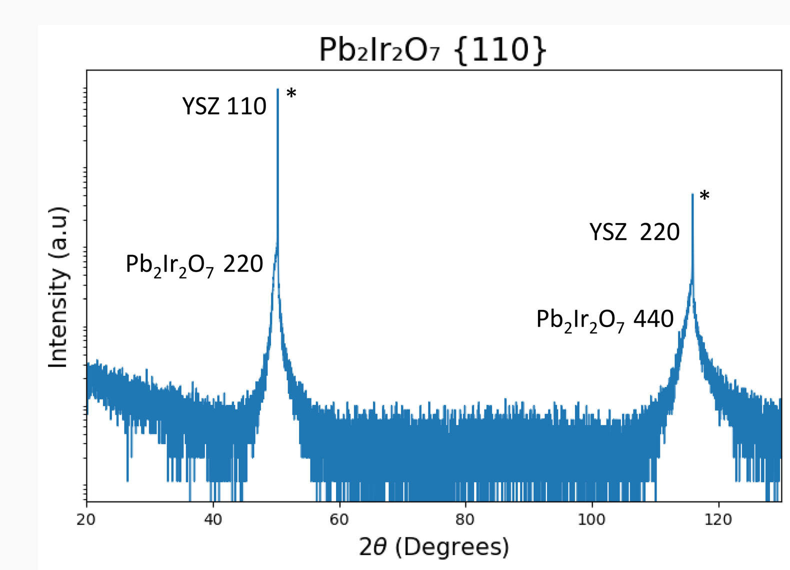



## X-Ray Diffraction: Crystal Structure

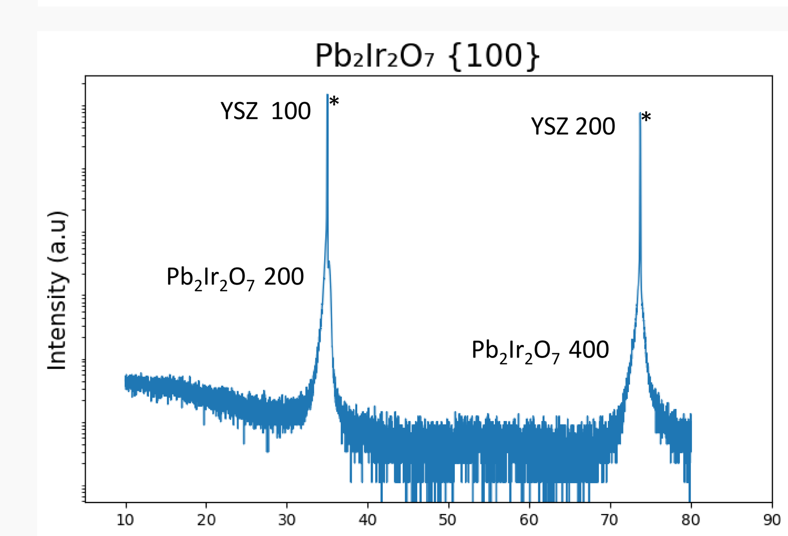
- Using XRD, we can see we have substrate peaks and **film peaks with no impurities**
- $Pb_2Ir_2O_7$ {111} has **growth fringes**, signifying a high-quality sample




- $Pb_2Ir_2O_7$ {110} has faint film peaks which illustrates how difficult it is to grow on this direction

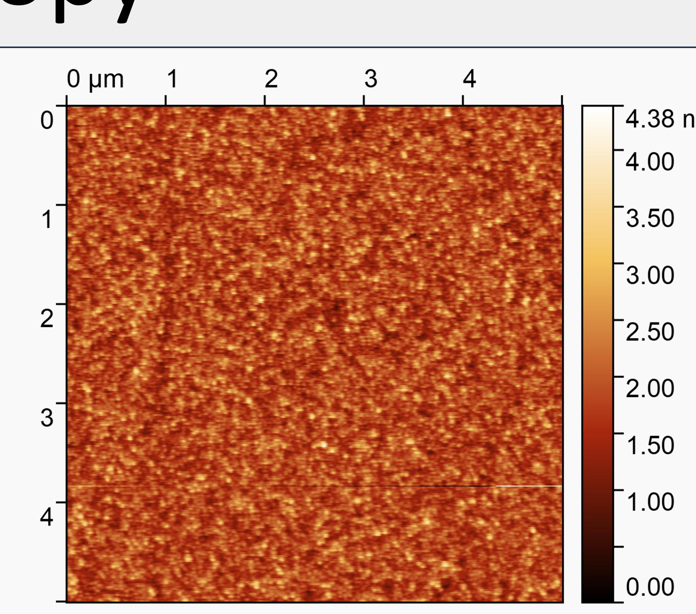



- $Pb_2Ir_2O_7$ {100} is similar and has faint film peaks showing this direction is difficult as well




## Atomic Force Microscopy

- Samples have many peaks and valleys
- Samples Range from 218.3pm-846.3pm in roughness
- Smooth enough for spin transport measurements




## Conclusions

- We successfully grew stoichiometric $Pb_2Ir_2O_7$ {111}, {110}, and {100}
- Unconventional spin torque in-plane $Pb_2Ir_2O_7$ {111}
- We have begun to grow $Bi_2Ir_2O_7$ {111}, {110}, and {100} to expand our spin transport study