Pb$_2$Ir$_2$O$_7$ 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$_2$Ir$_2$O$_7$ on YSZ
- Iridium has many unpaired electrons resulting in large amounts of spin torque
- Pb$_2$Ir$_2$O$_7$ and YSZ are both defect Fluorites
- Close lattice match
- Most spin transport is done on highly asymmetric crystals
- Pb$_2$Ir$_2$O$_7$ is cubic, so it is highly symmetric
- Different orientations may yield different spin torque

GOAL: Grow stoichiometric Pb$_2$Ir$_2$O$_7$ (111), (110), and (100) for spin transport

X-Ray Diffraction: Crystal Structure

Using XRD, we can see we have substrate peaks and film peaks with no impurities
- Pb$_2$Ir$_2$O$_7$ (111) has growth fringes, signifying a high-quality sample
- Pb$_2$Ir$_2$O$_7$ (110) has faint film peaks which illustrates how difficult it is to grow on this direction
- Pb$_2$Ir$_2$O$_7$ (100) is similar and has faint film peaks showing this direction is difficult as well

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

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$_2$Ir$_2$O$_7$ (111), (110), and (100)
- Unconventional spin torque in-plane Pb$_2$Ir$_2$O$_7$ (111)
- We have begun to grow Bi$_2$Ir$_2$O$_7$ (111), (110), and (100) to expand our spin transport study