High-Temperature Superconducting Thin Films

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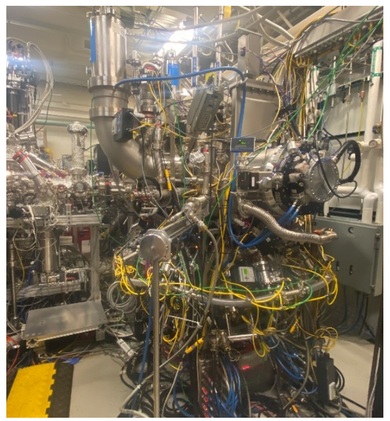
Introduction

- Super conducting thin films are everywhere from MRI machines to microwaves and can be used for efficient/renewable energy.
- Z. Hirioi at Kyoto university successfully achieved superconductivity in the orthorhombic phase of a strontium calcuim cuprate polycrystal
- Our goal was to recreate his research with a thin film instead of a polycrystal.
- The orthorhombic phase is when the three axes of the film are unequal
- Tetragonal phase has 2 axes the same and one different

Methods

- Strontium calcium cuprate was grown by Molecular beam epitaxy (MBE) on YAO.
- The substrate had been annealed at 1200°C for 2 hours prior to growing.
- 5%, 10%, and 20% cation deficiencies were created in films by varying flux ratios.
- The thin film was grown at 3 different temperatures for each percent deficiency.
- X-ray diffraction (XRD) was the primary characterization technique
- AFM was utilized to measure surface roughness.

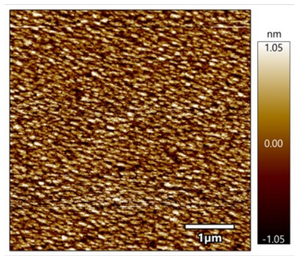


Results and Discussion

5% Cation Deficiency

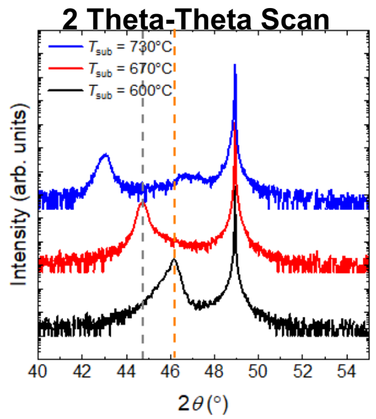
2 Theta-Theta Scan
730 °C no orthorhombic some tetragonal
670 °C majority orthorhombic very little tetragonal
600 °C No orthorhombic all tetragonal
AFM- very little roughness
No Superconductivity

AFM image



Roughness: 0.414 nm

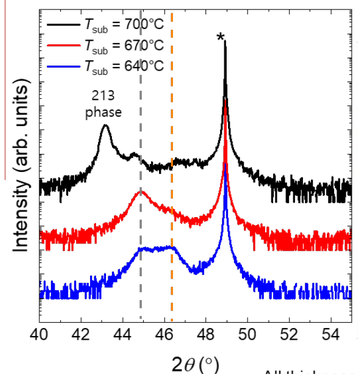
2 Theta-Theta Scan



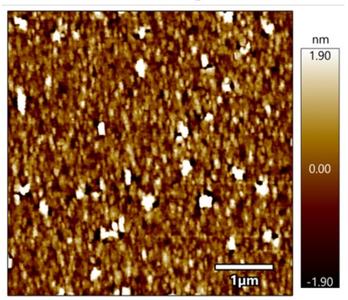
10% Cation Deficiency

2 Theta-Theta Scan
700 °C little orthorhombic little tetragonal
670 °C mostly orthorhombic some tetragonal
640 °C some orthorhombic some tetragonal
AFM- 50% more rough than 5% sample
No Superconductivity

2 Theta-Theta Scan



AFM image

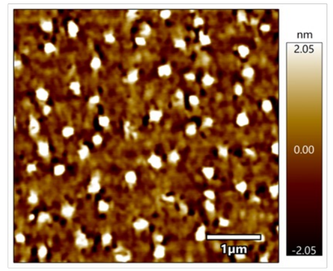


Roughness: 0.608 nm

20% Cation Deficiency

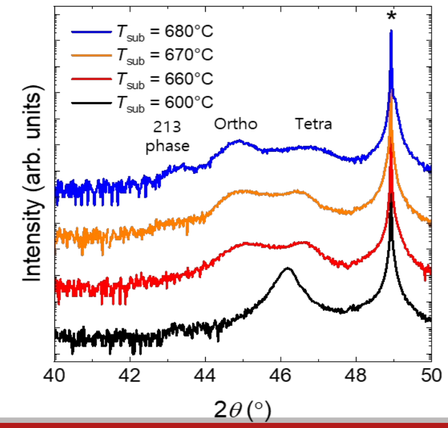
2 Theta-Theta Scan
680 °C some orthorhombic some tetragonal
670 °C some orthorhombic some tetragonal
660 °C some orthorhombic some tetragonal
600 °C some orthorhombic some tetragonal
AFM- slightly rougher than 10% sample
No Superconductivity

AFM image



Roughness: 0.682 nm

2 Theta-Theta Scan



Conclusions & Future Work

Conclusions

- We tried to synthesize superconducting thin films of orthorhombic $(Sr Ca_{1-y})_{1-x}CuO2$ (Tc:110 K) by MBE
- We were able to grow desired structure that exhibited superconductivity in
- polycrystalline samples
- However, our films were insulating and not superconducting

Future work

- We hypothesized and are currently testing if oxidizing the film immediately after growth will produce super conductivity
- We are also trying different models to produce a superconducting thin film

Acknowledgements

Thank you to PARADIM, Dr. Jinkwon Kim, Jim Overhiser, Darrell Schlom and the rest of Schlom group for their help and guidance throughout this project. Thank you to NSF for funding my research.

References

Z. Hiroi, M. Azuma, M. Takano, Y. Takeda, Structure and superconductivity of the infinite-layer compound (Ca1−ySry)1−xCuO2−z, Physica C: Superconductivity,Volume 208, Issues 3–4,1993,Pages 286-296,ISSN 0921-4534,