Optimizing Superconductivity in Sr$_2$RuO$_4$
Thin Films with Varying Cation Flux Ratio
Grown by Molecular-Beam Epitaxy

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**Introduction**
- Sr$_2$RuO$_4$ is extremely sensitive to disorder such as impurities and ruthenium vacancies
- Purity of Sr$_2$RuO$_4$ affects superconductivity
- Intergrowth of Ruddlesden-Popper perovskites should be avoided
- Ruthenium vacancies can also suppress superconductivity
- Vary the cation flux ratio to optimize the superconductivity in Sr$_2$RuO$_4$ thin films

**Experimental**
- Growth conditions were set by the thermodynamics of MBE (TOMBE) diagram at a substrate temperature of 940˚C and ozone pressure of 6x10$^{-7}$ Torr
- NdGaO$_3$ (110) substrate induces compressive strain for enhanced superconductivity

**Results**
- XRD patterns and rocking curves show higher crystallinity in the sample grown with a 2Ru/Sr flux ratio of 1.7
- XRD patterns show phase-pure growth
- Out-of-plane spacing of 12.769 Å, which is greater than the bulk value of 12.746 Å

**Conclusions**
- Phase-pure Sr$_2$RuO$_4$ thin films were successfully grown epitaxially on NdGaO$_3$ (110) substrates by Molecular-Beam Epitaxy
- The sample grown with a 2Ru/Sr ratio of 2.1 showed enhanced transport properties with the highest $T_c$ ever reported in this material
- We plan to study the magnetic structure of Sr$_2$RuO$_4$ by Mu ion scattering experiments
- We aim to minimize the thickness of the Sr$_2$RuO$_4$ film with the optimized flux ratio 2Ru/Sr of 2.1

**Acknowledgements**
I thank my mentor Dr. Jinkwon Kim and PI Professor Darrell G. Schlom for their support and guidance in this project. This research was funded by the National Science Foundation (NSF) Platform for the Accelerated Realization, Analysis, and Discovery of Interface Materials (PARADIM) under Cooperative Agreement No. DMR-2039380 as well as the NSF REU Site: Summer Research Program at PARADIM under Cooperative Assignment No. DMR-2150446.

**References**