Lucas Hardesty

EUROScholars

Universiteit Leiden

Stamping High-T_c BSCCO 2212 Flakes on Simple Metals

About Me

- 3rd - Year at Arizona State University
- Bachelors in Materials Science and Engineering
- Previous work includes: “Characterization of Chiral Material “InSeI”” and “Quantification of Pt Nanoparticle Fluxionality Using Image Processing”

Superconductivity: A Brief Overview

Superconductivity is characterized as the **absence of electrical resistance**. Superconductivity is a rare phenomenon that only occurs under conditions such as extremely low temperatures, usually marked by temperature T_C, making the benefits of superconductivity difficult to reach.

The mechanism of superconductivity is known as **Cooper Pairing**, which allows for a quantum state where energy is not dissipated/scattered through the material.

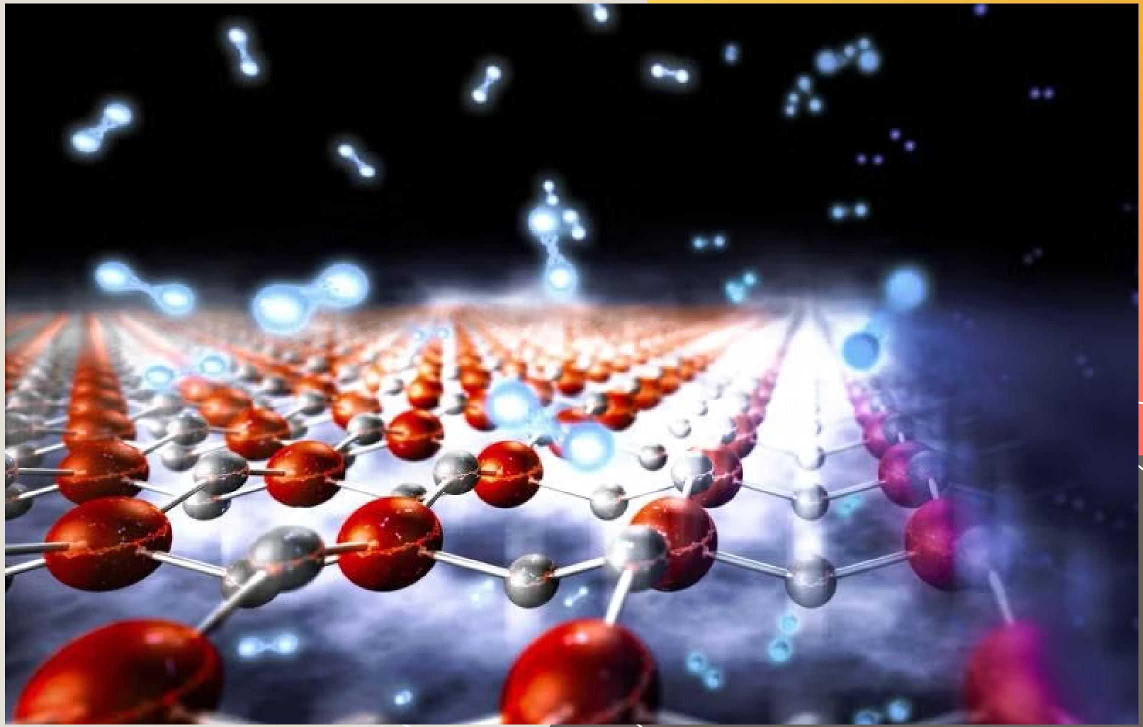


Photo: https://www6.slac.stanford.edu/topics/superconductivity?page=3

BSCCO (Bismuth strontium calcium copper oxide): A Brief Overview

BSCCO is a “Van der Waals” material, A material that has strong covalent bonds but can be easily separated by layer, allowing us to exfoliate BSCCO to create thin layers. BSCCO is also of interest because of its **High T_c** at around 96K (for BSCCO 2212).

Using mechanical exfoliation, we are able to obtain very thin layers of BSCCO 2212 and place it on top of other substrates.

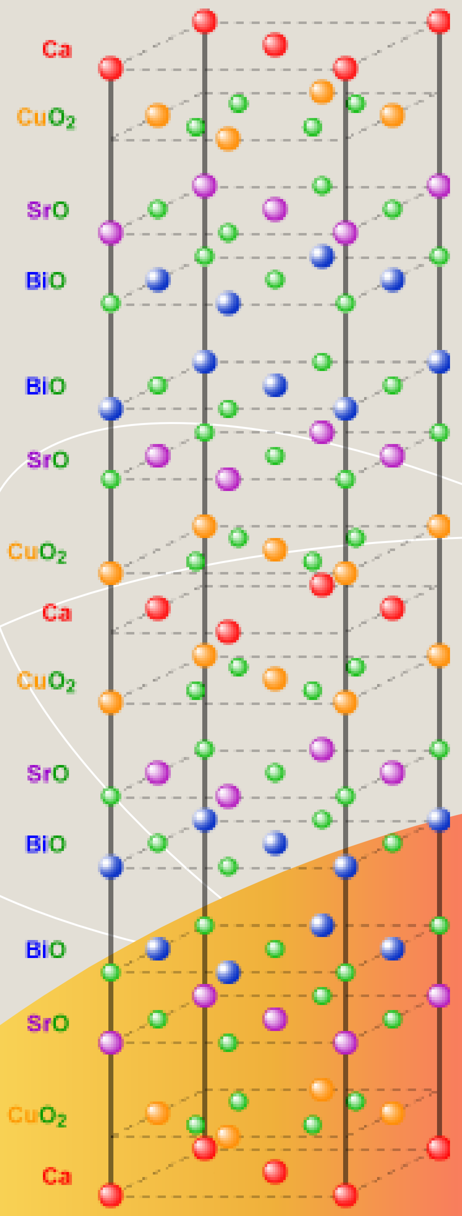


Photo: https://en.wikipedia.org/wiki/Bismuth_strontium_calcium_copper_oxide#/media/File:Bi2212_Unit_Cell.png

Can we induce Superconductivity by "Stamping" BSCCO onto simple metals?

Working Principle

Can the layered BSCCO act as a "electron reservoir" to induce Cooper Pairing and, therefore, increase the T_C of our simple metal?

Why Stamping?

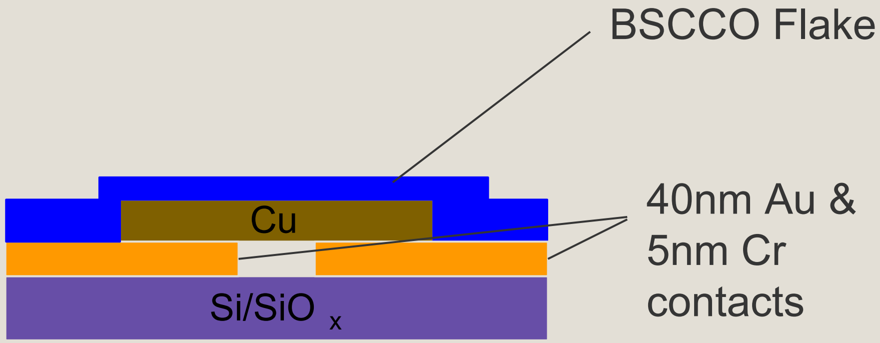
Stamping retains the structure of our BSCCO, while also eliminating the risk of "island growth" that would be introduced if we were to use Epitaxy or Sputtering techniques

Methodology

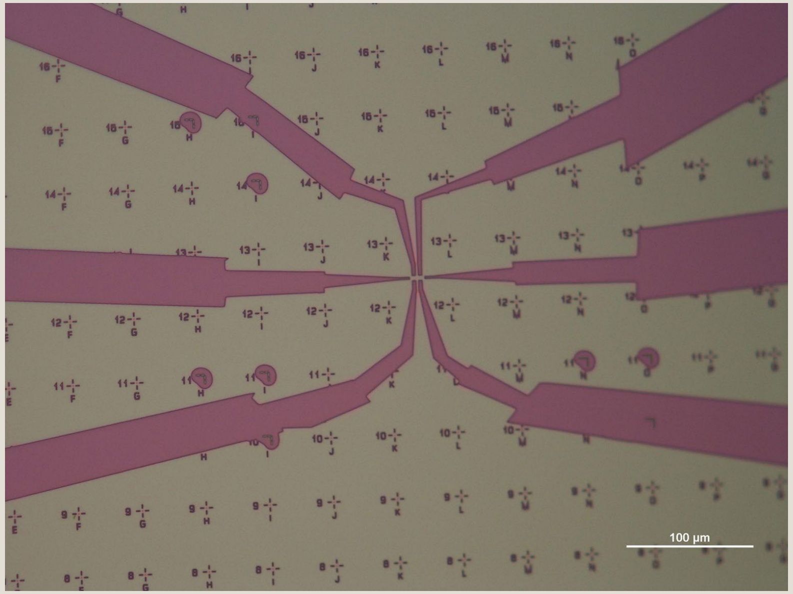
Due to the size of our BSCCO flakes and the measuring chamber size, we must create micrometer designs using E - beam Lithography. This will give our Copper contact to our Au and Cr deposit, which current will flow through, and also allow us to lay the BSCCO layer on top.

This design and scale allows us to **reduce the temperature** of our sample (down to ~1K) and **control where current is flowing, voltage, and amperage.**

Simple Diagram



Chip Design



Benefits of a Higher T_C

Applications

1 Higher T_C requires less energy to cool down

Superconductors are used in medical equipment, such as MRI machines, and a higher T_C could **reduce operating costs**.

2 Superconductors have zero resistance

A simple metal with superconductive properties and a high T_C could be used in large scale power grid systems to **increase efficiency** and reduce power loss.

3 Points 1 & 2 make superconductive materials cost effective and more accessible

Due to lower operating costs and increased accessibility, a high T_C superconductor could **allow for further research and applications** of materials with superconductive properties

Data (as of 30/10/2025)

Unfortunately, due to unforeseen flooding issues with the Huygens Building, our project has been delayed and we have no data to analyze at this point in time.

Thank You!
Questions?

Thank you to the EuroScholars Team, Leiden University, KU Leuven, and the Aarts Lab at Leiden University