Fabrication and characterization of exfoliated high-temperature superconductor $Bi_2Sr_2CaCu_2O_{8+\delta}$ flakes for van der Waals heterostructures

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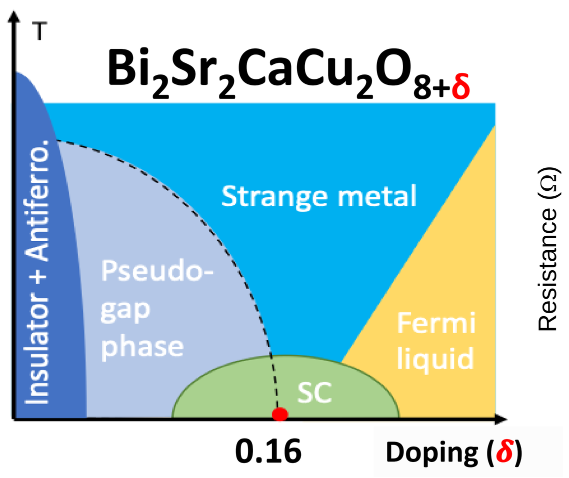
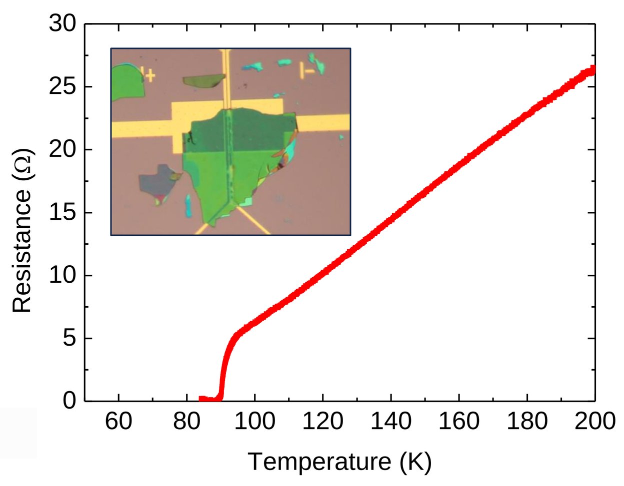
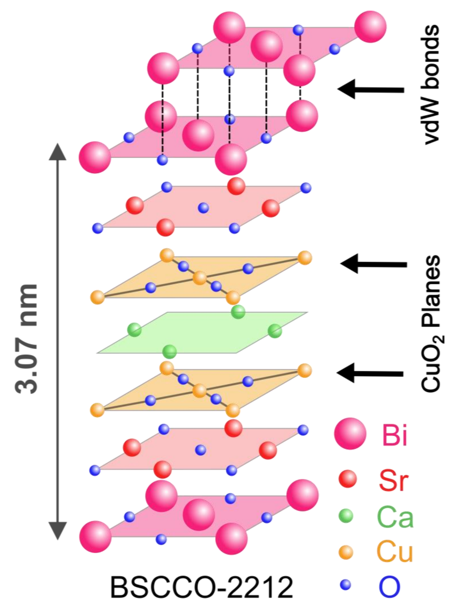
1 INTRODUCTION

$Bi_2Sr_2CaCu_2O_{8+\delta}$ (BSCCO-2212) is a correlated oxide material that presents different phases due to electronic correlations[(1)]. These phases can be accessed by doping the material with holes via oxygen doping (δ).

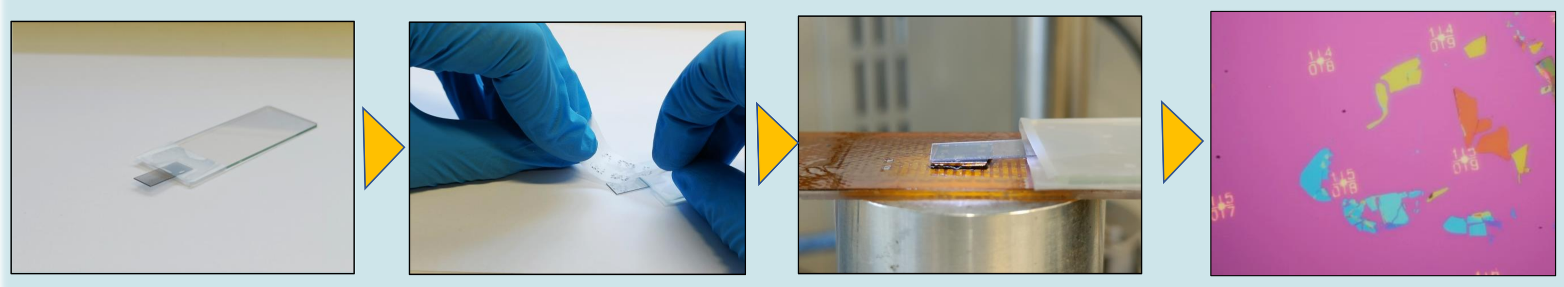






2 FABRICATION

VISCOELASTIC STAMPING[(2)]



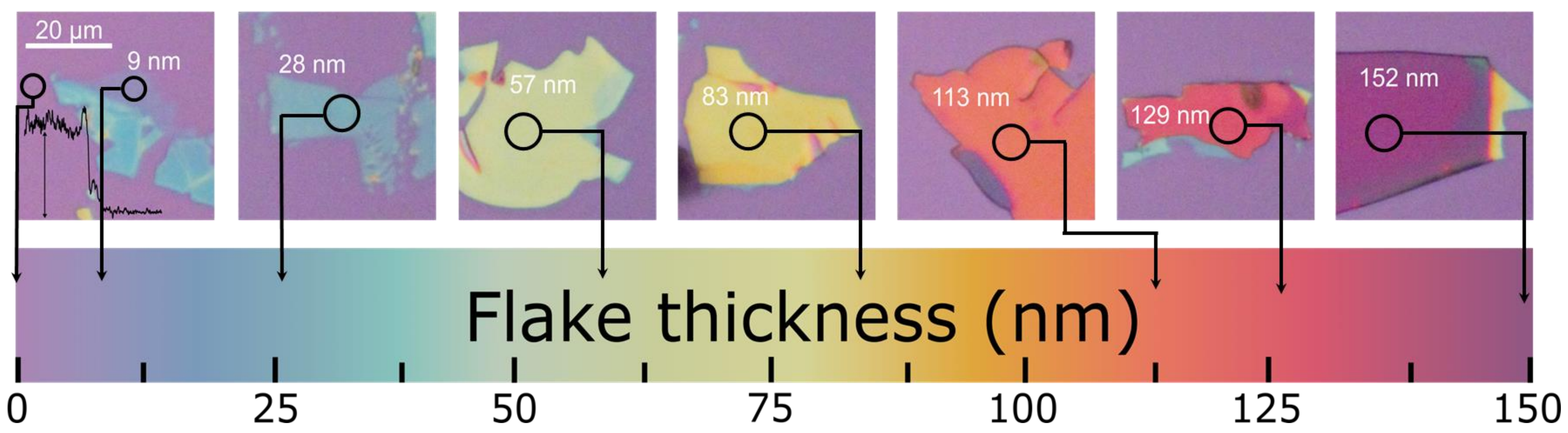
PDMS + Glass slide → Peeling flakes from scotch tape in PDMS → Stamping the PDMS with flakes on substrate → Different flake scatter on SiOx/ Si substrate

Challenge: BSCCO air sensitivity + thickness control

Solution: Glove box fabrication + non invasive techniques

3 APPARENT COLOR

Flakes with different thickness present different color due to different optical paths. AFM measurements were performed to build a thickness - color chart [(3)] for easy flake identification:



4 OPTICAL CONTRAST

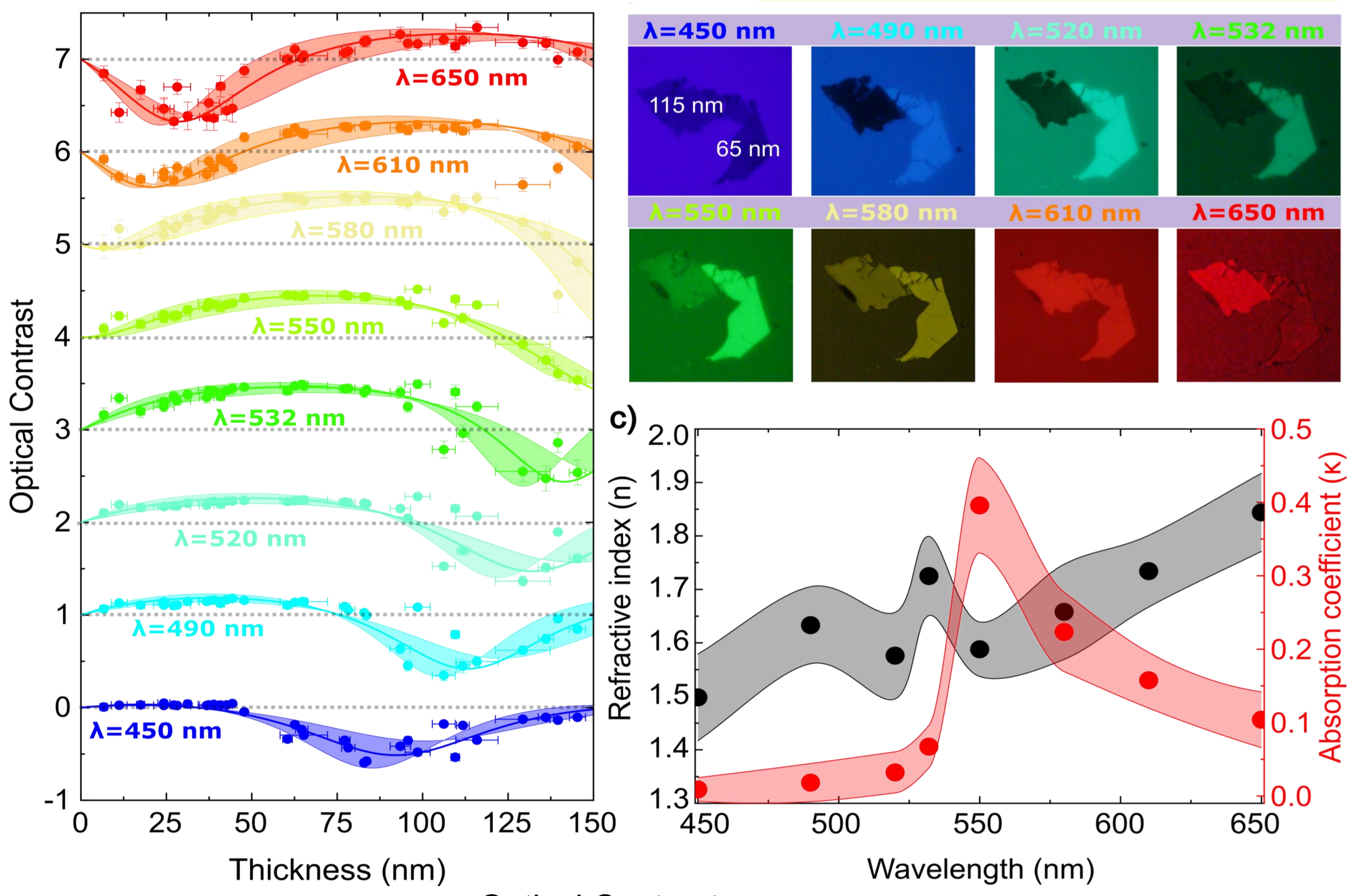
Under monochromatic illumination we define a magnitude called **Optical Contrast (O.C.)**. Based on a **multilayered Fresnel model** [(3)] we can extract microscopic parameters:

$$O.C. = \frac{I_{Flake} - I_{Sub.}}{I_{Flake} + I_{Sub.}}$$

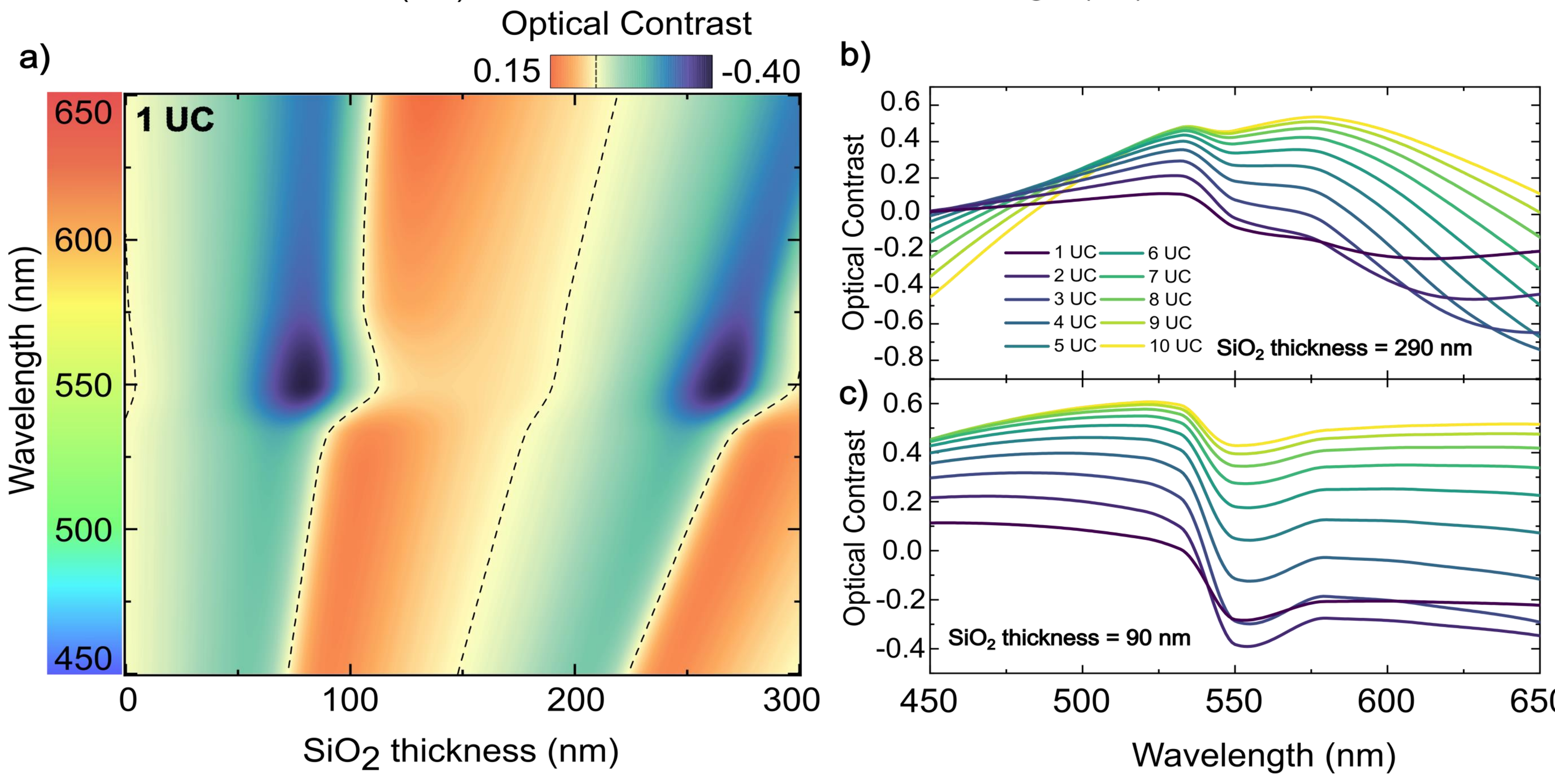
Darker than substrate O.C. < 0

Brighter than substrate O.C. > 0

EXPERIMENTAL WORK

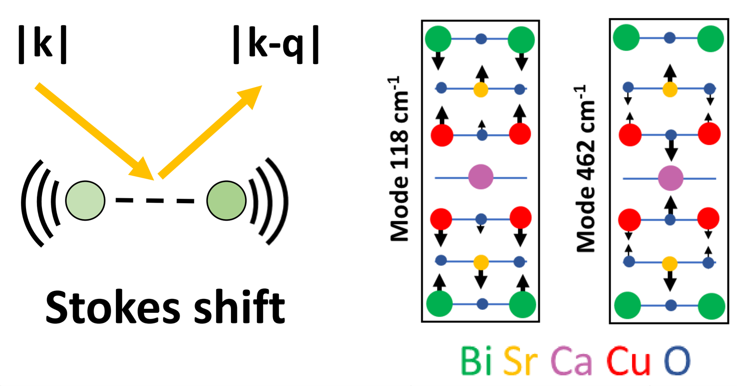


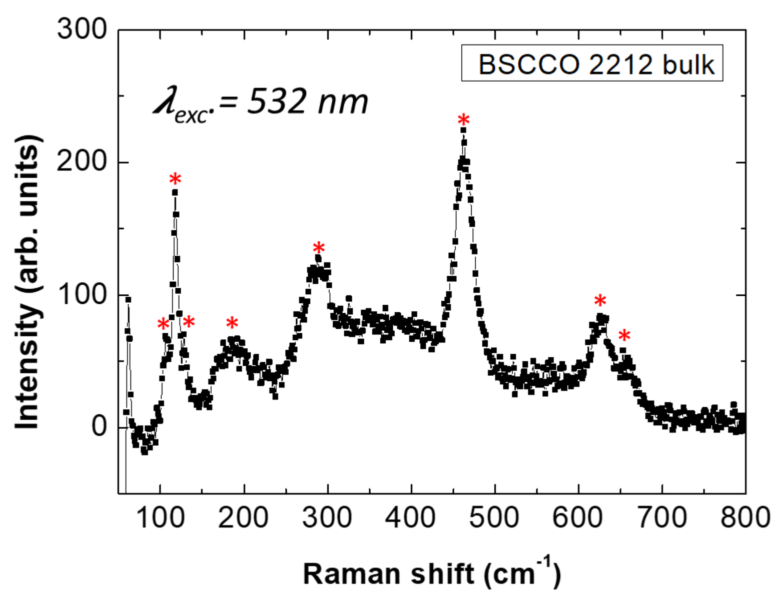
THEORETICAL MODELING



5 RAMAN SPECTROSCOPY

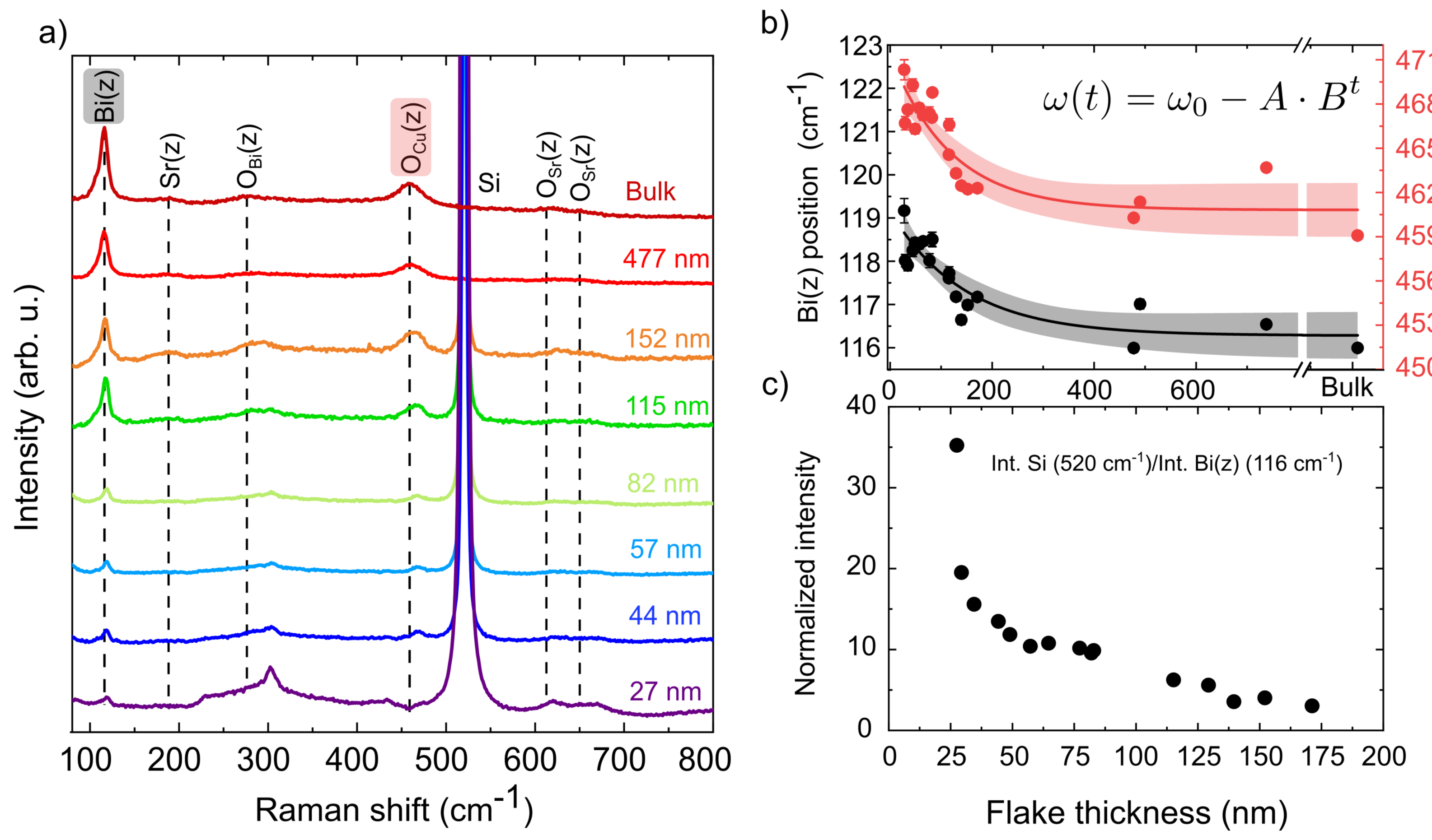
Raman spectroscopy can be sensitive to flake thickness and can be used to identify structural properties:





Raman shift [cm-1]	107	118	128	185	290	462	629	652
Assignment[(4)]	Cu(y)-Sr(y)	Bi(z)	Cu(z)	Sr(z)	O_{Bi} (z)	O_{Cu} (z)	O_{Sr} (z)	O_{Sr} (z)

Raman modes harden as thickness is reduced:



6 FINAL REMARKS & FUTURE WORK

- BSCCO-2212 air degradation can be circunvented by carefully working in a glove box.
- **Apparent color** can be used as a first estimation for thickness identification.
- **Optical contrast** is more accurate for thickness identification and **Fresnel model** can be used to extract the refractive index of the flakes.
- **Raman spectroscopy** results show that vibrational modes are modified by thickness and can be used for thickness calibration.
- Future work will include **Raman simulations** to understand the **Raman hardening** seen in experiments.

References

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