In-Situ Detwinning and Measurement of the Ultrasonic Properties of $La_{2-x}Sr_xCuO_4$

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Introduction

The pseudogap in the cuprates is of great interest to physicists because it may hold the key to the mechanism of high temperature superconductivity. Recent resonant ultrasound spectroscopy (RUS) measurements at LANL have explored the pseudogap in $YBa_2Cu_3O_{6+x}$, and it is desirable to see if the same behaviour is seen in all cuprates. One challenge specific to LSCO is that the material undergoes a tetragonal to orthorhombic phase transition right in the temperature region of interest[1], resulting in twin domains and a loss of signal. We are constructing an RUS probe at NHMFL-LANL that can de-twin the crystals in-situ, and aligning and polishing samples to the accuracy required for these experiments.

Experimental

Recent progress has been made for alignment and polishing of the samples. The Laue diffractometer at LANL has been used to align crystals to better than 0.5°, and the samples are subsequently cut and polished along the crystal axes that will allow for easy detwinning. Visualization of the twins is also now possible due to the construction of polarizing filters for a light microscope in the lab.

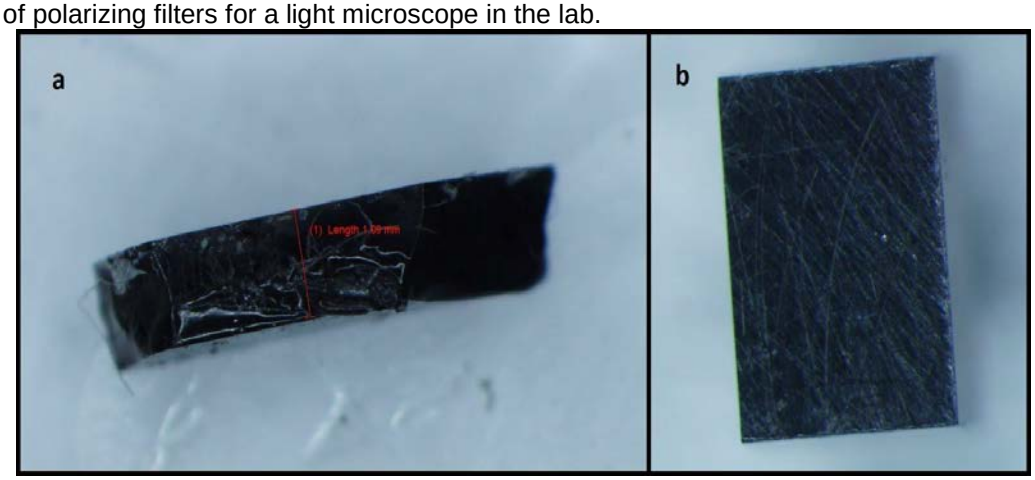

Figure 1: a. Single crystal of LSCO with two faces polished, perpendicular to the c-axis, and the as-grown crystal face exposed. **b.** The same a-c face shown in panel a, but now roughly polished square.

Results and Discussion

The sample, once prepared as in **Figure 1 b**, has resonance quality factors (Q's) of up to 20,000 at low temperature, on par with ultra-high-quality YBCO single crystals, indicating the quality of these samples.

Conclusions

Alignment and polishing of LSCO single crystals appears to do no internal damage to the crystals, as evidenced by the high quality factors. The next step is to perfect the probe for detwinning and measurement; in the current iteration of the probe, the weight on crystals as small as those in **Figure 1** is too great, and makes it impossible to see the resonances.

Acknowledgements

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References

[1] Yamada, K., *et al.*, Phys. Rev. B, 57, 6165-6172 (1998).