

# Growth of Bi-2212 Superconducting Whisker Crystals

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## Abstract

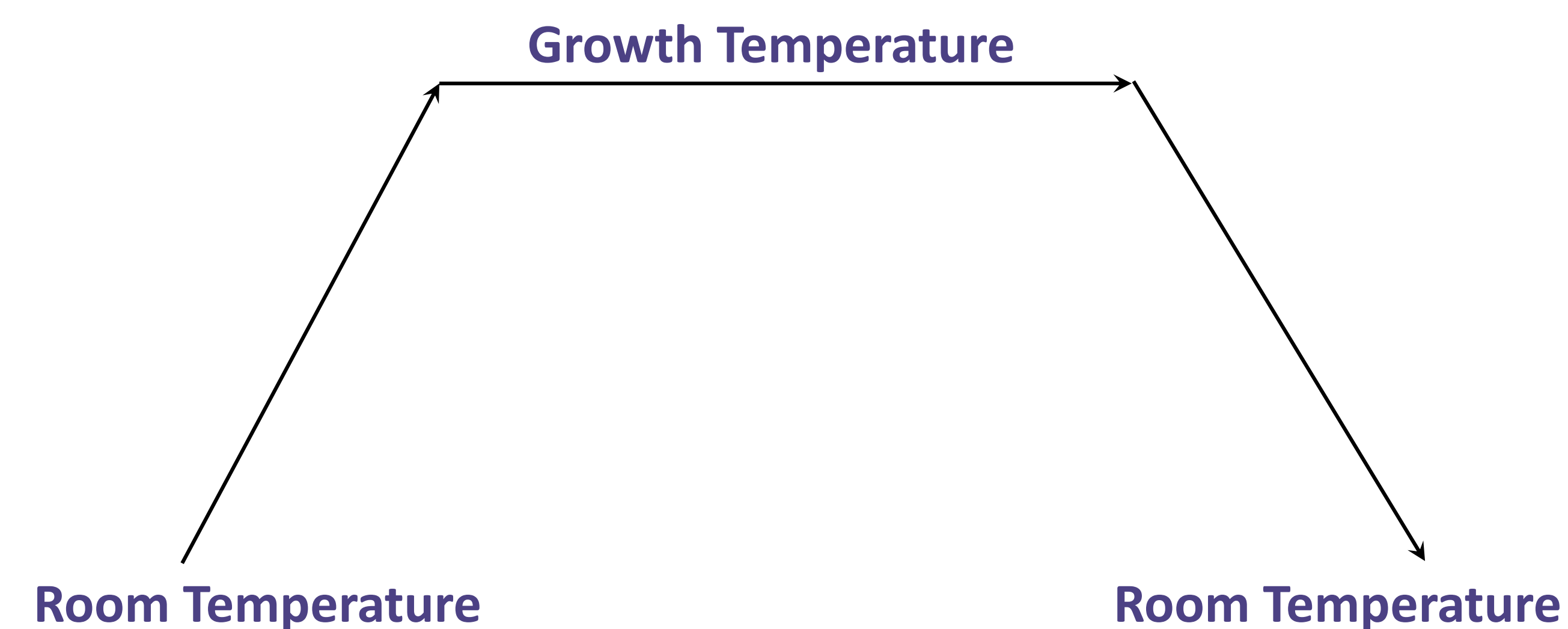
- We grew  $\text{Bi}_2\text{Sr}_2\text{CaCu}_2\text{O}_x$  (Bi-2212) whisker crystals that exhibit zero resistance at temperatures below 96 K (-177 °C).
- We did this to understand how the zero-resistance current flows across the Bi-2212 grain boundaries.
- We found that the growth of Bi-2212 whiskers heavily depends on the oxygen flow rate.

## Introduction

- Bi-2212 superconductor is a high temperature superconductor that is particularly useful for very high field magnets beyond 25 T. [1]
- Bi-2212 whisker crystals allow for research on different grain boundaries and their effects on supercurrent flow.
- We conducted detailed work on Bi-2212 whisker growth and critical current characterization of various grain boundaries.

## Methods

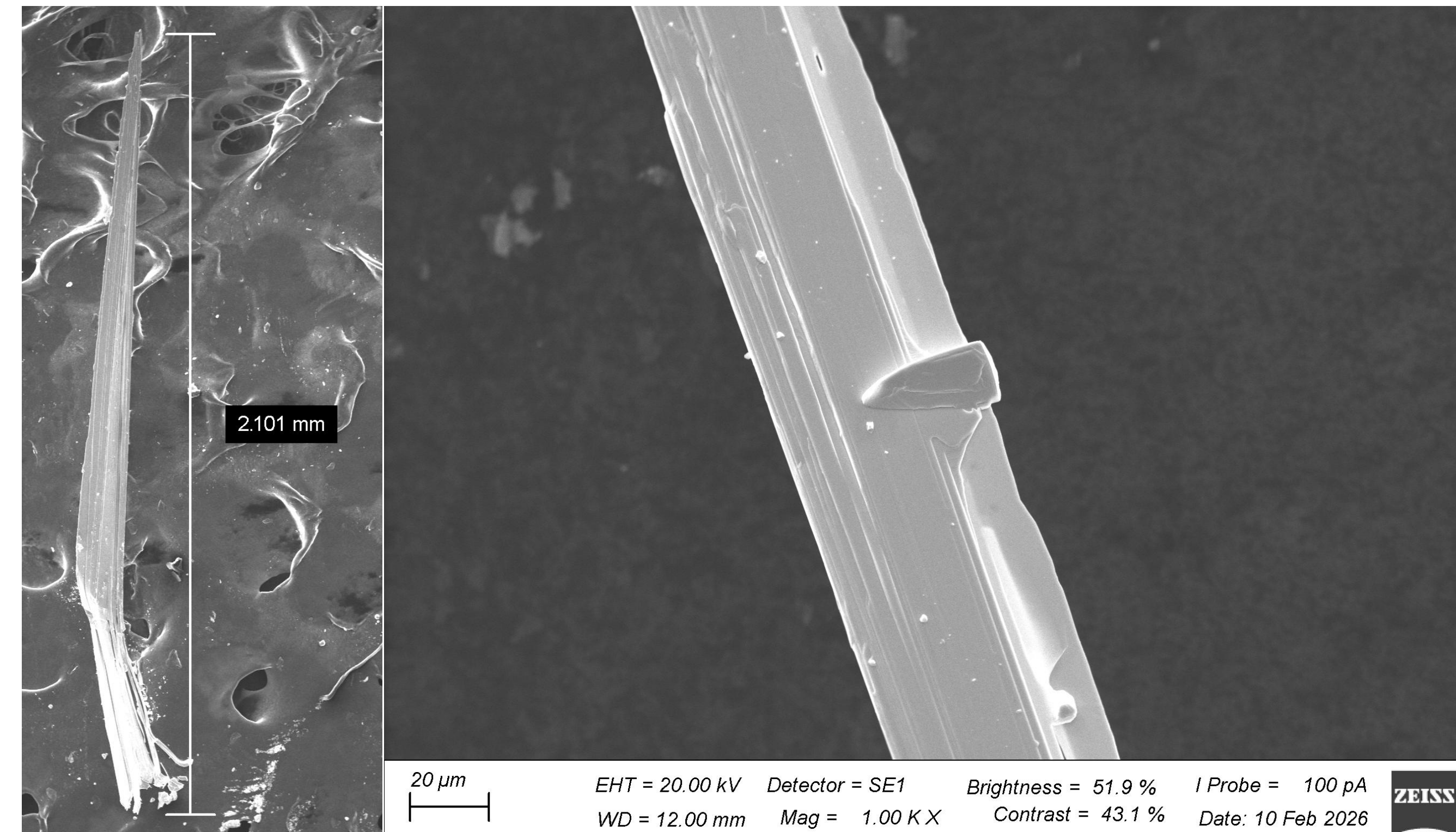
1. Place Bi-2212 glassy plate precursor in an alumina boat
2. Load the alumina boat with the Bi-2212 glassy plate into a tube furnace
3. Grow Bi-2212 whiskers at temperatures above 800 °C in a flowing oxygen environment



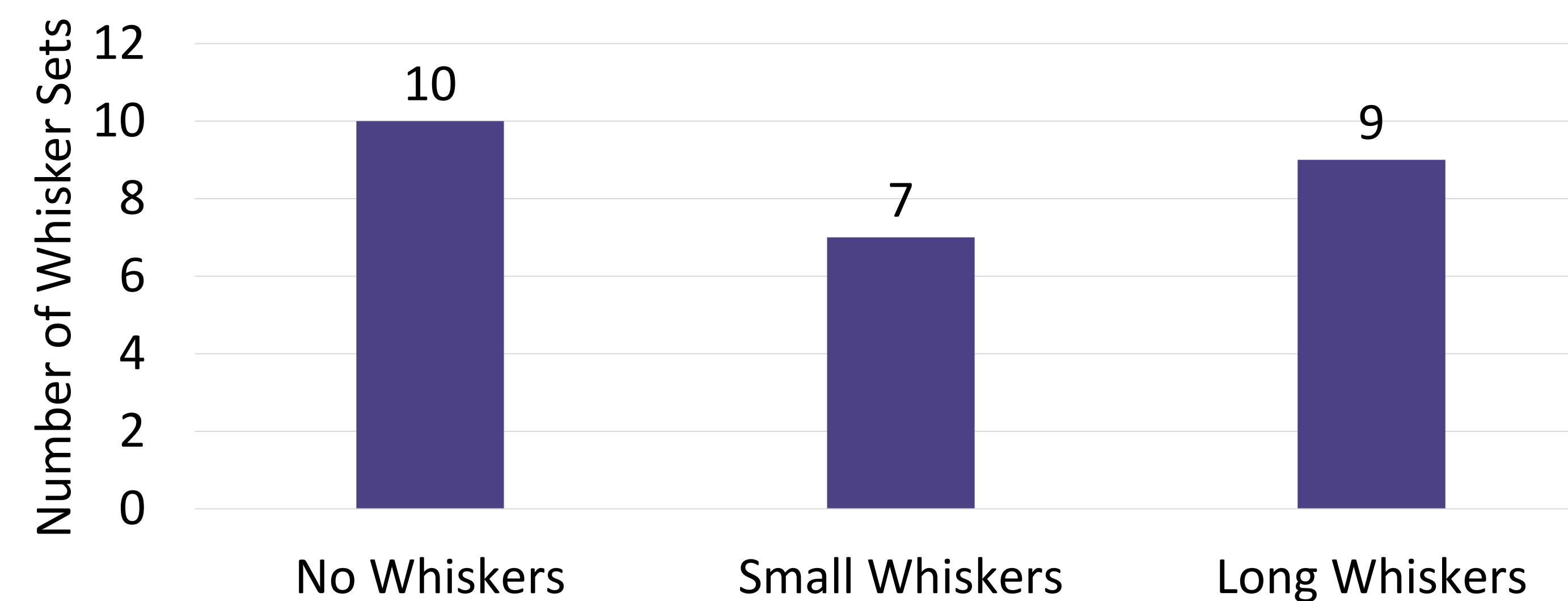
4. We varied the oxygen flowing rate to investigate how the flowing rate affects Bi-2212 whisker growth

## Results

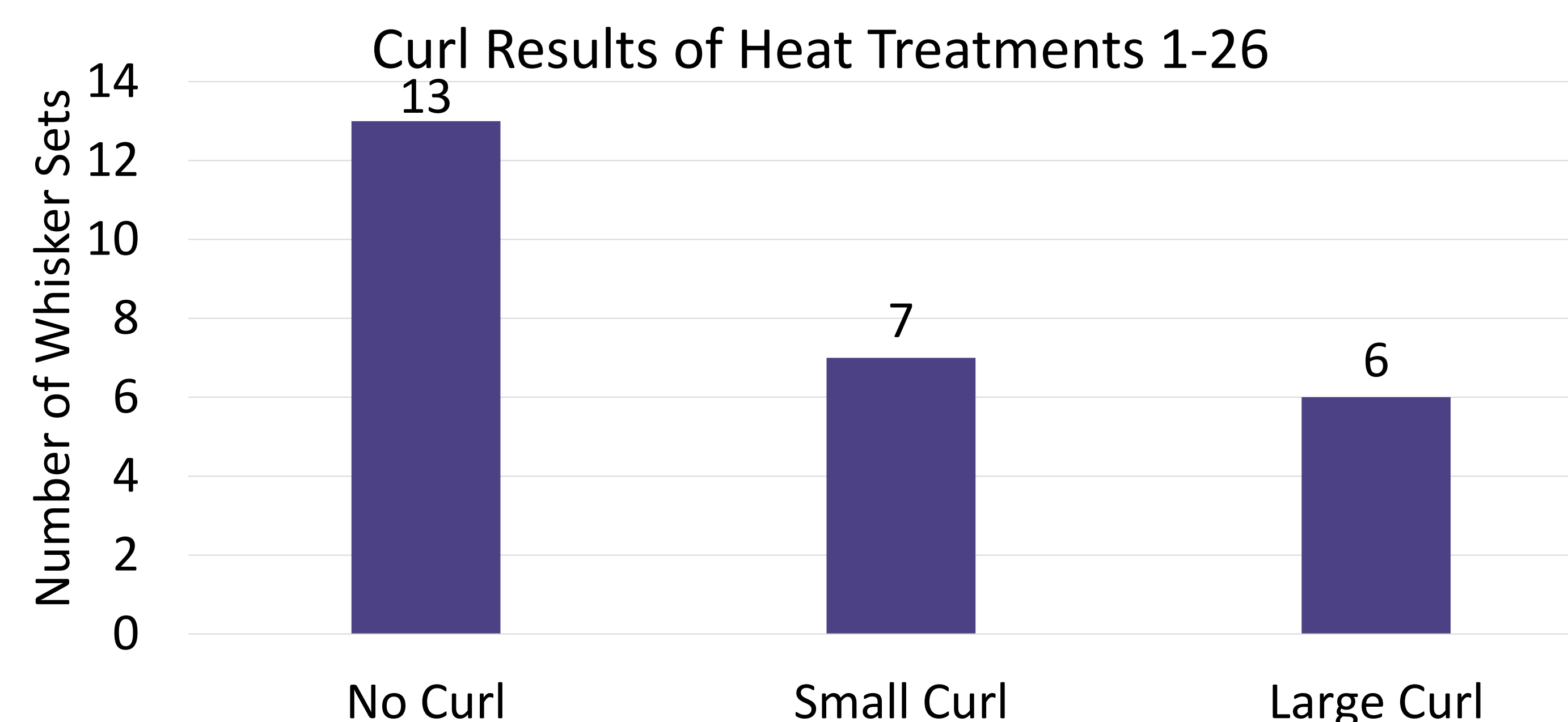
### 1. We have successfully grown Bi-2212 whiskers.



Whisker Results of Heat Treatments 1-26



### 2. The growth of whiskers correlates well with the occurrence of glassy plate curling.



## Conclusions

- Whiskers were successfully grown in 62% of the 26 heat treatments.
- Long whiskers, with length greater than 4 mm, were successfully grown in 35% of total heat treatments.
- Bi-2212 glassy plate curling was observed in 50% of the heat treatments.
- Whiskers grow on both uncurled and slightly curled plates, but not on heavily curled plates.
- The oxygen flow rate is a leading factor in curling. Too high of an oxygen rate leads to curling.

## Next Work

- Optimize Bi-2212 growth conditions to attain whisker length above 10 mm
  - Oxygen flow rate
  - Growth temperature and time
  - Size of Bi-2212 glassy plates
- Test grain boundary properties using Bi-2212 whiskers

## References

1. D. C. Larbalestier et al., *Nature Materials*, vol. 13, pp. 375-381, March 2014, doi: 10.1038/nmat3887
2. J. Jiang et al., *IEEE Transactions on Applied Superconductivity*, vol. 33, no. 5, pp. 1-5, Aug. 2023, doi: 10.1109/tasc.2023.3236870
3. I. Matsubara, et al., *Materials Research Bulletin*, vol. 35, no. 3, pp. 441-447, Feb. 2000, doi: 10.1016/s0025-5408(00)00219-1

## Acknowledgements

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