

Quantifying Electrical Anisotropy in Pure Copper Bicrystals: Mechanistic Insights and Implications for Next-Generation Interconnects

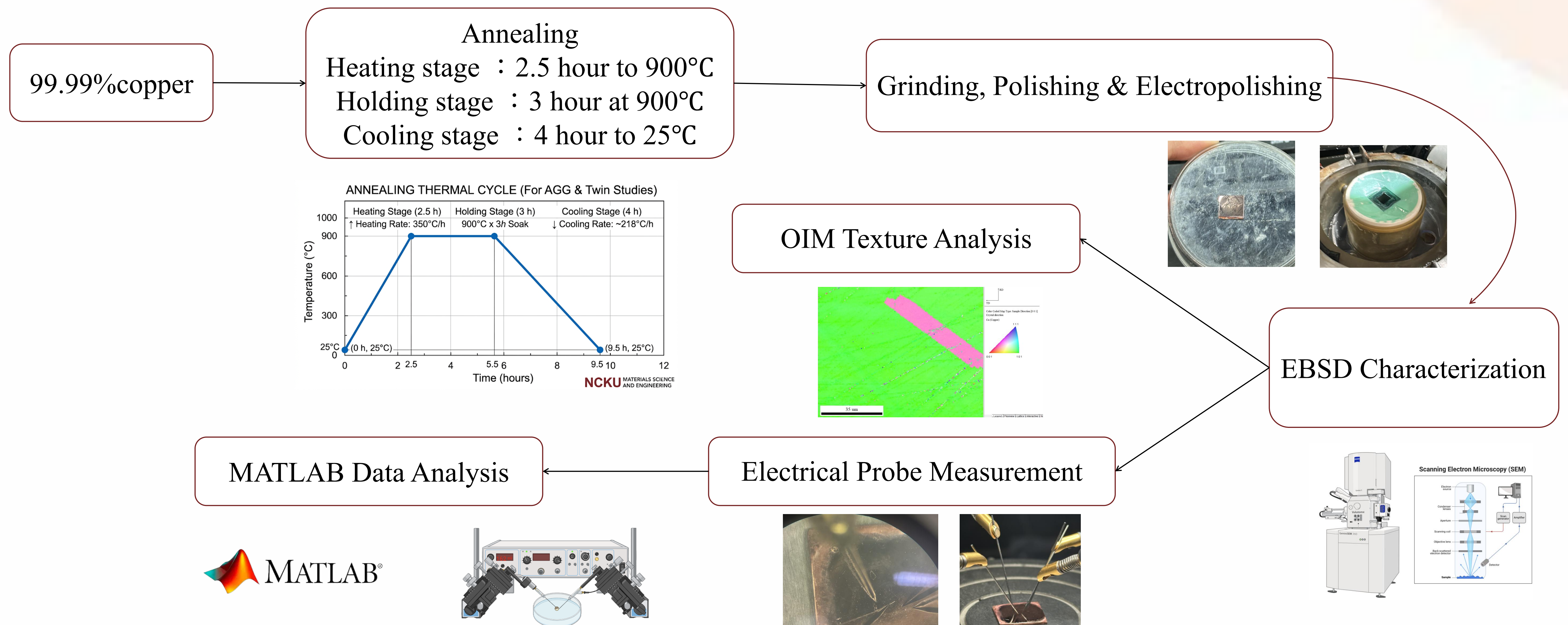
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Abstract

This project investigates how microstructural evolution affects electrical measurement accuracy. We observed abnormal grain growth and twin structures in the samples. Notably, comparing two-point and four-point probe methods revealed significant discrepancies. To identify the root cause, we used OIM to generate pole figures, enabling us to rotate the sample at specific angles to analyze the influence of different crystallographic planes on the measurements, highlighting the critical relationship between crystal structure and measurement reliability.

Procedure of Experiment sample : 99.99% copper



Results

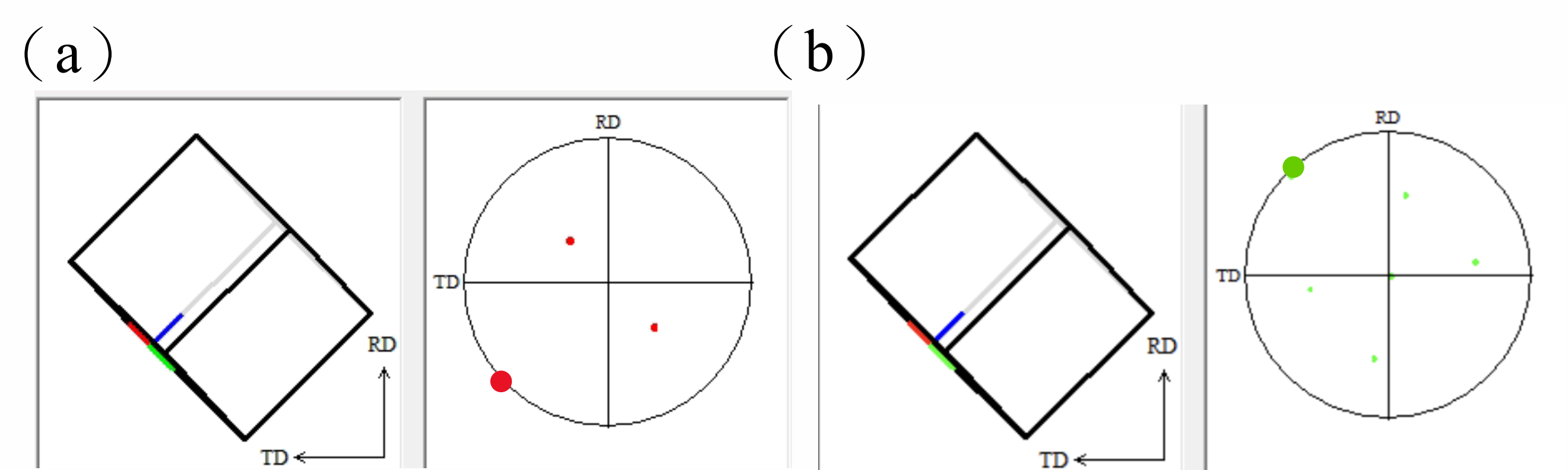


Fig. 1: Pole Figure of (a) [100] as ND (b) [110] as ND

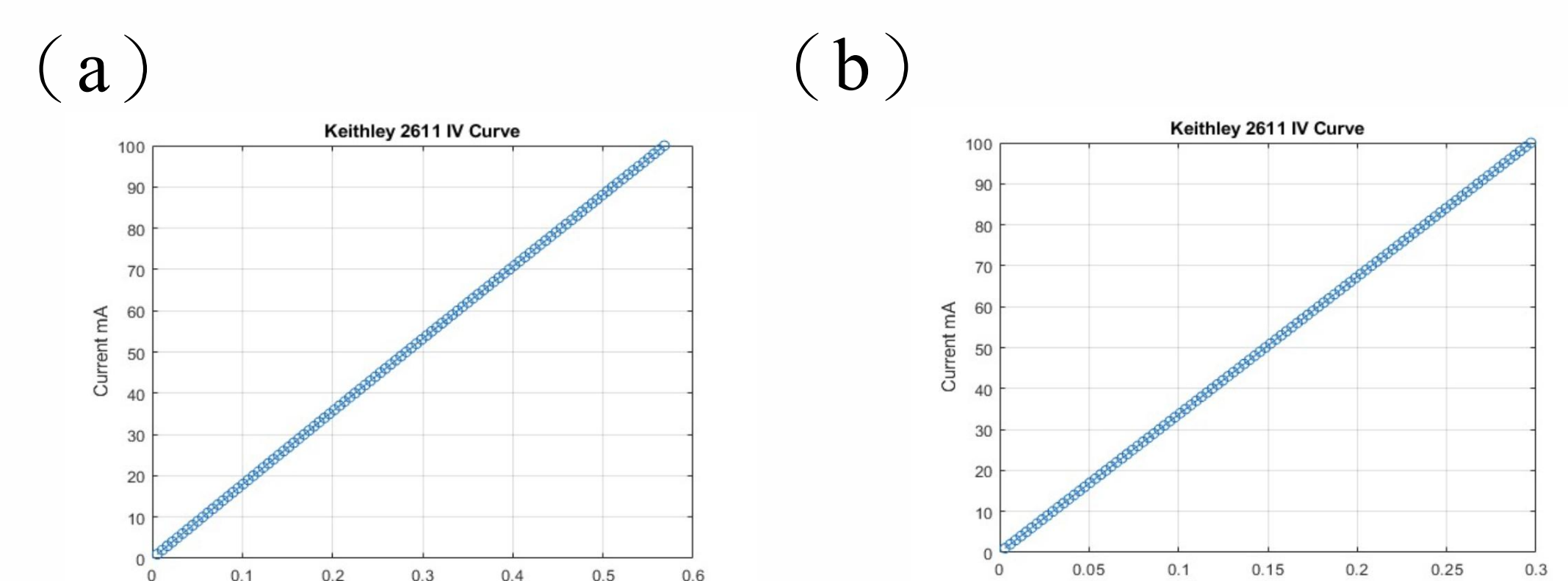


Fig.2 2-Point Probe Resistivity IV Curve of (a) (100) plane (b) (110) plane

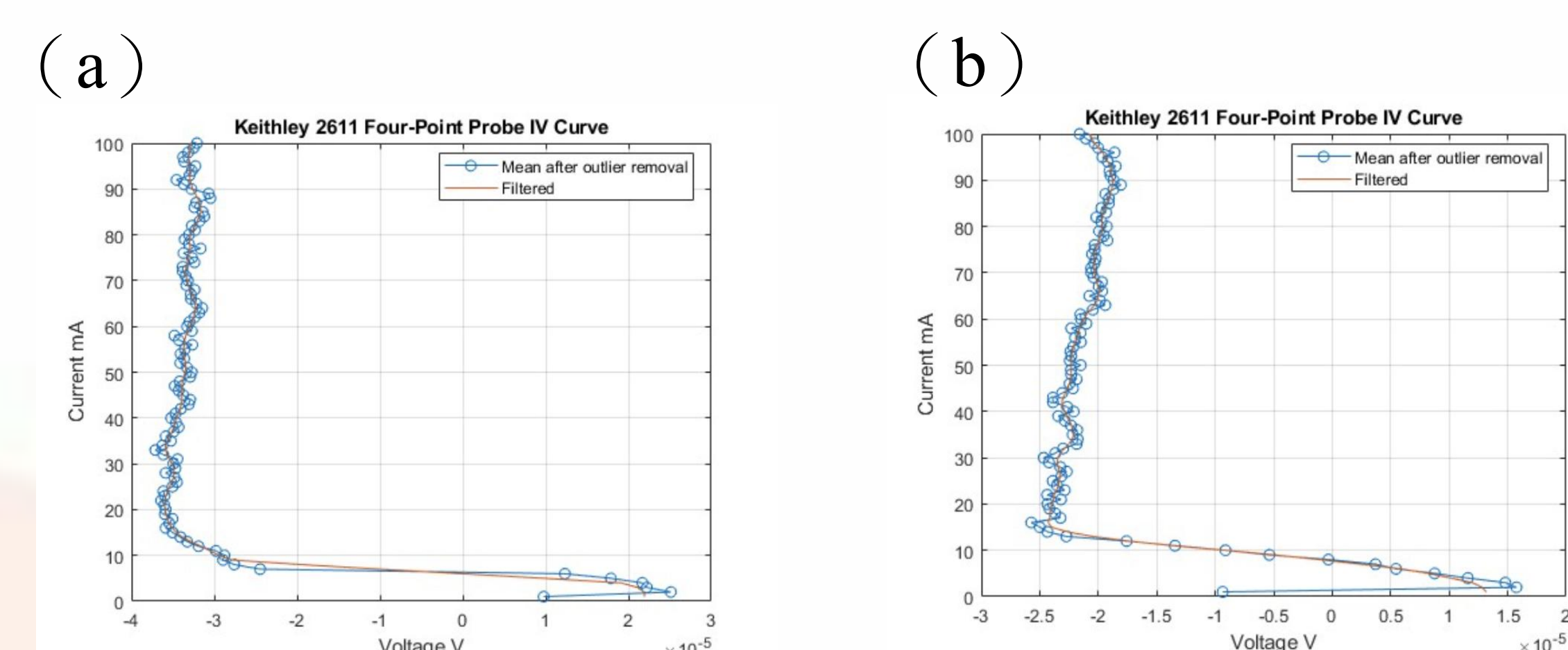


Fig.3 4-Point Probe Resistivity IV Curve of (a) (100) plane (b) (110) plane

Comparison of Probe Configurations: Two-point measurements were entirely dominated by interface contact resistance (0.3~0.6V), whereas four-point setups successfully eliminated this artifact to capture the intrinsic μV level response, from which the true metal resistance was precisely extracted via MATLAB linear slope $\Delta V/\Delta I$ analysis.

Conclusions

By rotating the sample $\pm 45^\circ$ about the ND axis to align with OIM pole figures, a distinct resistance discrepancy was quantified between (100) plane ($\sim 20.00\mu\Omega$) and (110) plane ($\sim 18.75\mu\Omega$), successfully demonstrating the crystallographic electrical anisotropy in high-purity copper.

Reference

- [1] G. Gottstein, Physical Foundations of Materials Science (1st ed.). Springer-Verlag Berlin Heidelberg, New York, 2004.
- [2] I. Miccoli, F. Edler, H. Pfnür, C. Tegenkamp, The 100th anniversary of the four-point probe technique: the role of probe geometries in isotropic and anisotropic systems, Journal of Physics: Condensed Matter, 27 (2015) 223201.