

Current pulse switching of gray and white tin

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White tin exhibits superconductivity with critical temperature 3.7K while gray tin is semiconducting with the band gap $E_g = 0.018\text{eV}$. We demonstrated the reversible transformation between semiconductor-tin (gray tin) and metallic superconductor-tin (white-tin) by applying current pulses.

I. INTRODUCTION

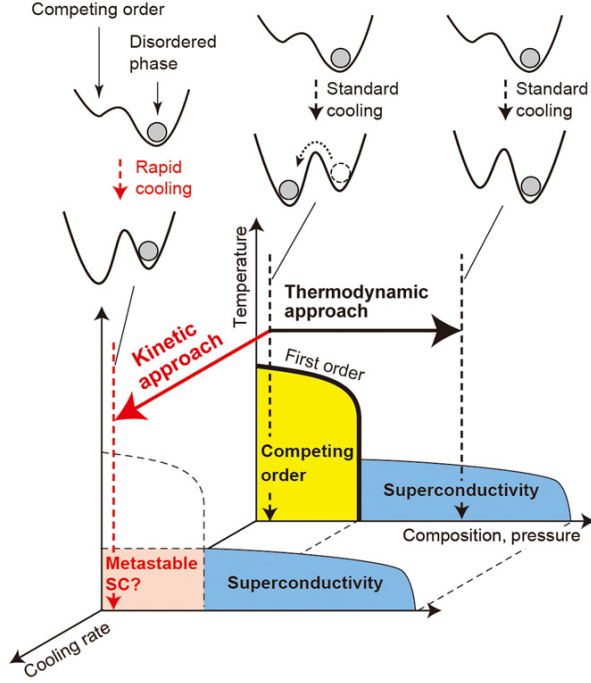


FIG. 1. some schematics is needed

II. METHOD

A. Sample preparation

Metallic Sn-Ge alloy was converted to semiconductor in a freezer. Pure Ge-drops (Furuuchi chemical GEM-33001A) were grind, and mixed with pure Sn-drops (Furuuchi chemical SNM-67027A) in a mass ratio 1:99 in a quartz tube. The tube was evacuated and heated up to 1050°C and cooled slowly in 48 hours in a electric oven. The melted sample were metallic, and we converted to semiconductor phase in a household freezer for a week.

B. Connections

Sample was

C. Resistivity measurement

The resistivity under slow cooling was measured with the conventional four-probe method. A load resistor of 150 ohms was connected in series with the sample. An AC voltage excitation of 105 Hz with a magnitude corresponding to $\sim \mu\text{A}$ was generated at a lock-in amplifier (Stanford Research SR830) and applied to the circuit. Signals from the voltage probes were amplified with a transformer amplifier (Stanford Research SR554) and measured with the lock-in amplifier. The current flowing through the circuit was measured by probing the voltage drop at the load resistor with a multimeter (Keithley 2001).

D. Pulse application

A rectangular voltage-pulse generated in a source meter (Keithley 2400) was amplified using a precision power amplifier (NF Corporation 4502) by $A=100$. A load resistor of 5.4 ohms was connected in series with the sample and used to calculate the current flowing through the circuit. The time-varying voltages at the load resistor and the sample voltage-probes were monitored using a data logger (Measurement Computing DT8824). Thus, we obtained the time profiles of the current and sample resistivity during the pulse application.

III. DISCUSSIONS

slow?

IV. CONCLUSION

We demonstrated the reversible transformation between semiconductor and metallic tin by applying current pulse.

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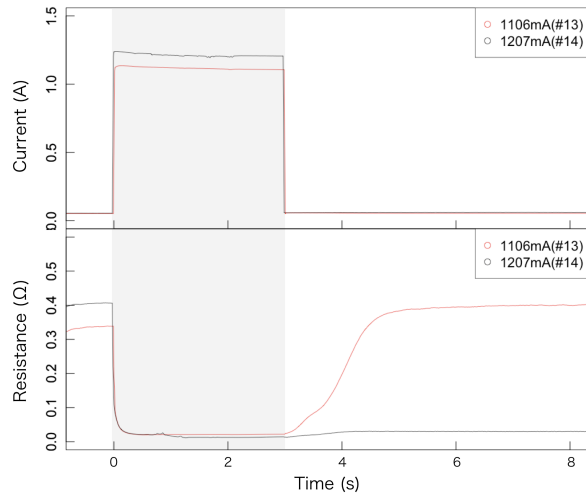


FIG. 2.

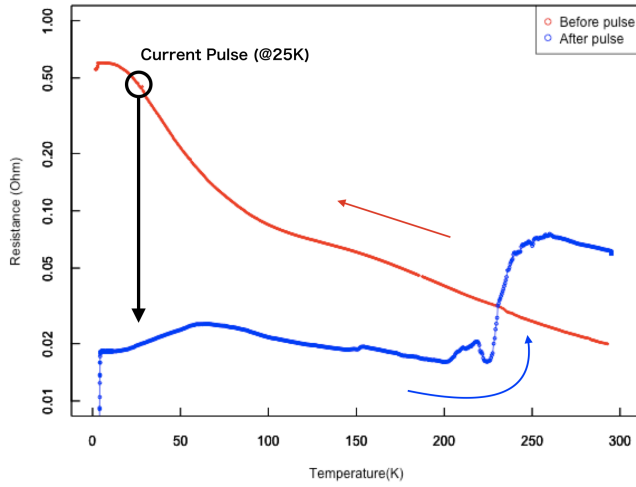


FIG. 3. a graph that demonstrates superconductivity should be inserted in the inset

V. SUPPLEMENTARY MATERIALS

Supplementary material for this article is available at

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ACKNOWLEDGMENTS

This work was partially supported by the Japan Society for the Promotion of Science KAKENHI (grant nos. 18K13512 and 18H01168). The authors thank A. Kikkawa for technical support in sample preparation and T. Nakajima for technical support in X-ray crystallography.