

# Current pulse switching of gray and white tin

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White tin exhibits superconductivity while gray tin is semiconducting. We demonstrated the reversible transformation between semiconductor-tin (gray tin) and metallic superconductor-tin (white-tin) by applying current pulses.

## I. INTRODUCTION

## 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  $\sim 1 \mu\text{A}$  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. RESULTS

## IV. DISCUSSIONS

slow?

## V. CONCLUSION

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

## VI. SUPPLEMENTARY MATERIALS

Supplementary material for this article is available at ...

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