



COULOMB BLOCKADE THERMOMETER

PICO-GROUP

LOW TEMPERATURE LABORATORY

A Coulomb blockade thermometer, CBT, is a mesoscopic thermometer. It can be used as a primary thermometer and therefore does not need calibration. CBTs have a wide operation range and can be used at temperatures between 20 mK and 20 K and even in strong magnetic fields.

A typical CBT is made from an array of metallic islands, connected to each other through a thin insulating layer. A tunnel junction forms between the islands, and as voltage is applied, electrons may tunnel across this junction. The tunneling rates vary according to the charging energy of the islands as well as the thermal energy of the system. The I-V properties of a CBT thus vary according to temperature; this is how CBT can be used as a thermometer.

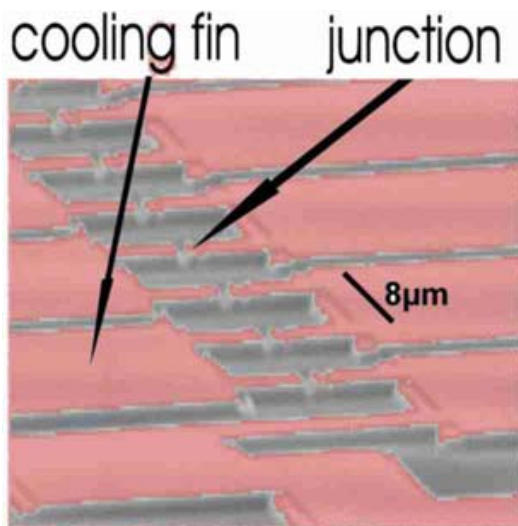


Figure 1: A CBT sample with multiple islands. Large cooling fins have been attached to help the thermometer to function at lower temperatures.

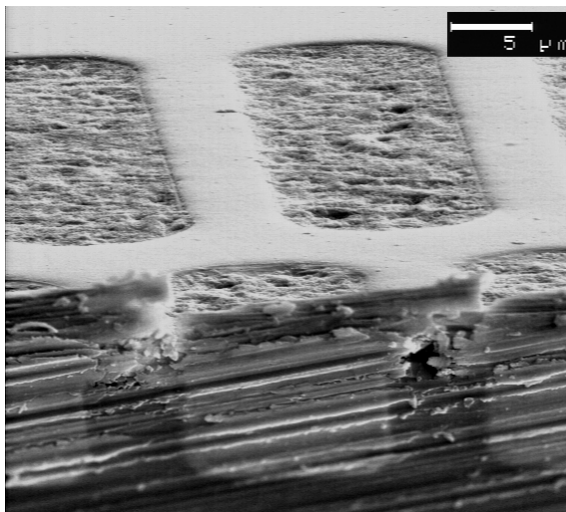


Figure 2: Copper blocks have been embedded in a silicon-chip. These copper blocks may help to better thermalize the sensor and make the CBT function at lower temperatures. (Courtesy of Antti J. Niskanen, TKK Microelectronics Centre)

RECENT RESULTS

The CBT has already a wide operation range, yet it would be beneficial if it could be used at even lower temperatures. To obtain this goal, copper blocks have been embedded in a silicon wafer on which CBTs may be deposited. If evaporation on such a chip will be successful, the copper blocks may serve as three-dimensional cooling fins thus ensuring thermalization down to about 10 mK temperature. This work is done in collaboration with MIKES and TKK Microelectronics Centre.

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