# Current-biased transition-edge sensors based on re-entrant sup

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## Background

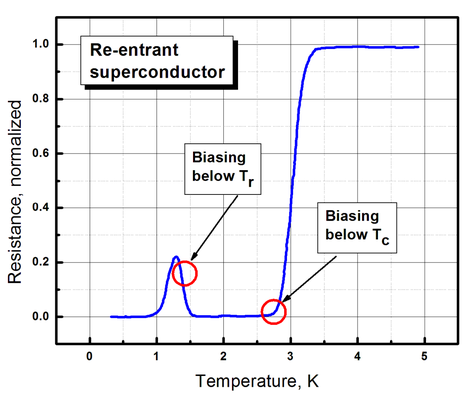
Transition-edge sensors are widely recognized as one of the most sensitive tools for the photon and particles detection in many areas – from astrophysics to quantum computing. Their application became practical after understanding that rather than being biased in a constant current mode, they should be biased in a constant voltage mode. Despite the methods of voltage biasing of these sensors are well developed since then, generally the current biasing is more convenient for superconducting circuits. Thus transition-edge sensors (TES) designed inherently to operate in the current-biased mode are desirable.

## Objectives

- Develop a design for TES detectors based on the re-entrant superconductivity, so that following the absorption of a photon it does not yield a latching.
- Prototype this transition edge sensor and tested them operational in accordance with the outlined physics.
- Introduce newly discovered re-entrant superconductor.

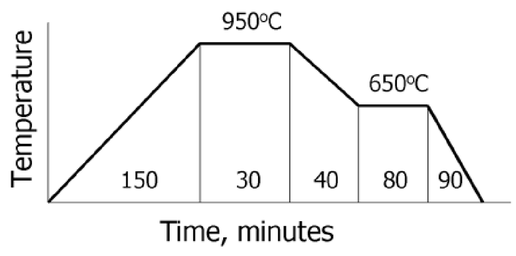
## Methods

### Preparation

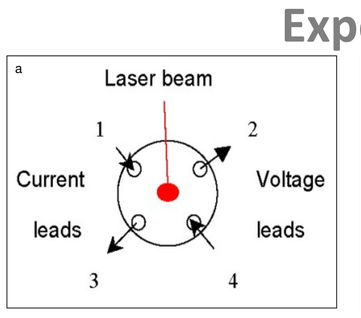


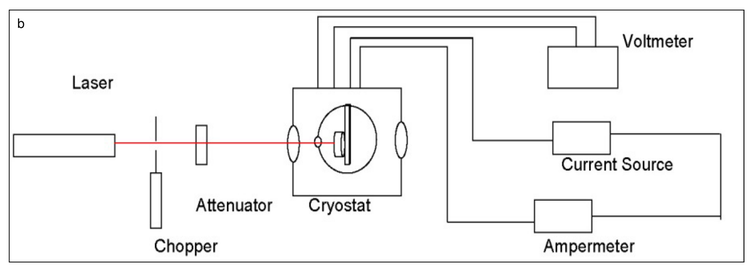

- **Exemplary R(T) behavior of a re-entrant superconductor.**
- **Two biasing options are reasonable for the TES operation.**

- **Solid-state synthesis**
- **Mixing, calcinating, re-grinding, pelletizing**
- **4mm in diameter x 1 mm in height**
- **Final baking in accordance to the temperature profile:**




### Experimental Procedures




- Very simple bolometric detector: a ceramic button biased in a constant current mode.
- 2 indium contacts for current, 2 for voltage probe on the same face of the button.
- Mounted on a cold finger in the closed cycle optical cryostat (PT/ST 405, Cryomech Inc.).
- Laser beam was directed through the cryostat window onto the center of the pellet.
- Chopper was used to obtain the detector response in the AC-mode..
- He-Ne laser with l=630nm, maximum power ~0.5mW, and beam diameter ~1.5mm.
- Sample holder was cooled down to 2.72K and held at that temperature.
- Attenuation using neutral filters.
- Direction of current was reverted to exclude thermoelectric pick-up.

## Samples

- At smalle voltage a when the
- At larger *I~0.6mA* than with
- Initial bia re-entran currents and climb
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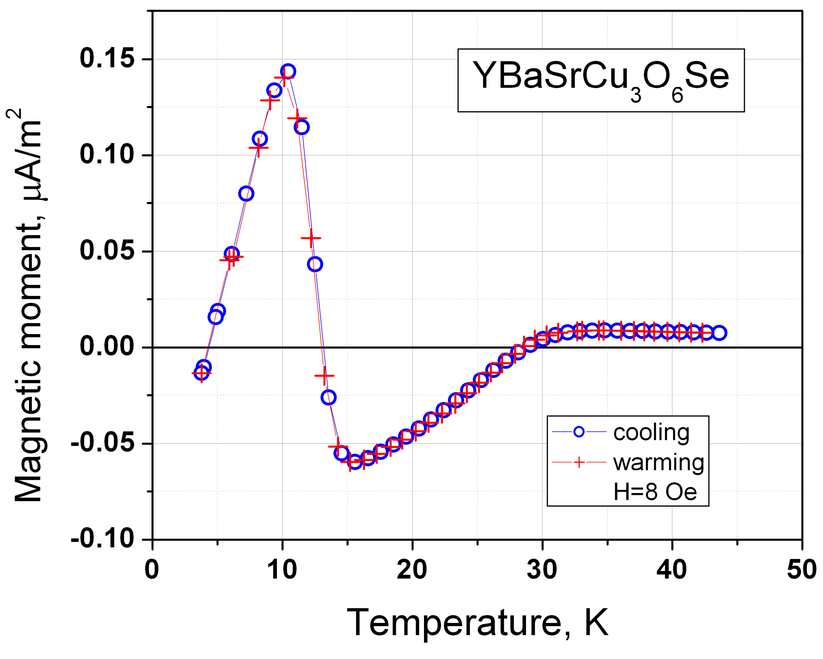
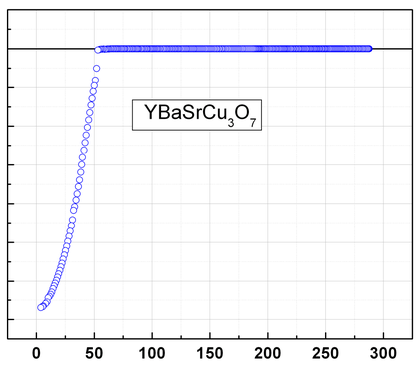
- The laser elevating

## Results

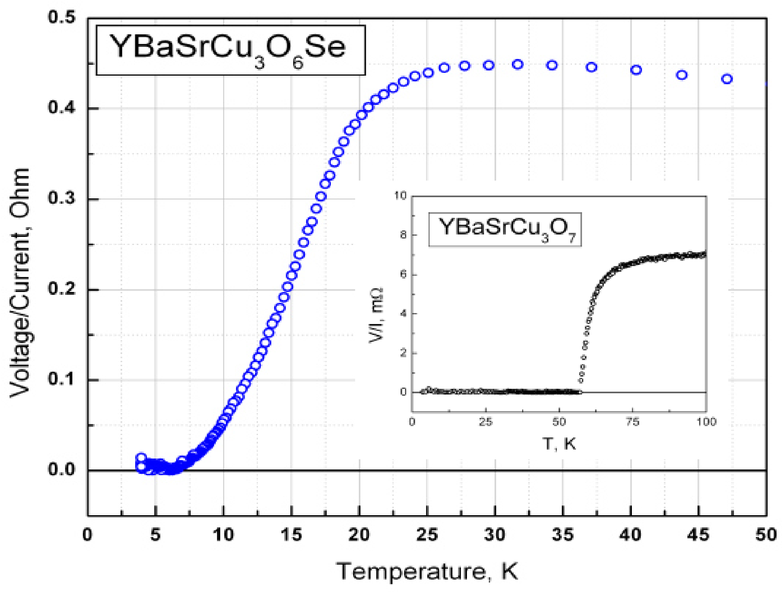
### Magnetic and Resistivity Characteristics of New Material




Magnetic momentum is measured using commercial SQUID-magnetometer (S-700, Cryogenic Inc.).




Magnetization vs. temperature for these materials. Re-entrant superconductivity only when both Se and Sr are present.




Resistivity is measured with 4-probe technique, at 0.3 mA current, with periodic reversion of current direction to eliminate thermoelectric pick-up.

This measurement is in agreement with that of magnetization: re-entrant superconductivity occurs only when both Se and Sr are present.