Novel sensor for accurate thermal detection with high spatial resolution

Summary

Devices for accurate sensing of small temperature differences (below the 0.01 K range) with high spatial resolution, are scarce, and normally based on complex architectures.

The technology presented here provides a simple device, without the need to include complex circuitry, capable of measuring temperature variations in the ≈10^{-6} K range, with a very high spatial resolution. The device has applications in fields where determining the position of hot point (induced by the impact of a laser, for example) with high resolution is crucial.

The invention

The device is a temperature measuring device comprising a thin-film of magnetometallic material, which generates an electric voltage in response to a temperature gradient, in the presence of a magnetic field. This voltage can be easily measured by metallic contacts in one-side of the thin-film. From the measurement of this voltage it is possible to obtain information about local variations of the temperature.

State of development

A prototype was built to carry out the measurements and verify the theoretical studies

Advantages

- Very large temperature resolution in nanostructures (10^{-6} K)
- Very large spatial resolution (only limited by the lithographic process, ±250 ηm)

Applications

- Experimental assessment of nano-materials. Characterization of materials with customized thermal/electrical conductivity properties
- Thermal characterization of thin-films. Attaching the sensor to a thin-film it is possible to obtain its heat transfer map measuring the voltage produces by the sensor
- High accuracy measurement of very small temperature differences (μK) in thin-films, both across the film and along the surface
- Improve microcalorimetry accuracy
- Systems for determining the exact impact point (±250 μm) of a radiation or particles
- Other applications in fields where determining the position of hot point (induced by the impact of a laser, for example) with high resolution is crucial

More information: http://www.ibridgenetwork.org/usc/thermal_position_detector

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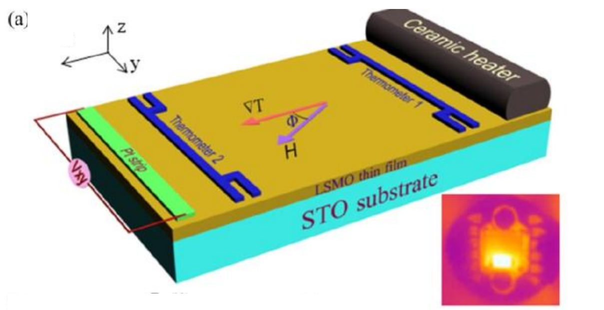

Figure 1. Sketch of the device used to measure the PNE and ANE in a thin film (5x5 mm², and 35 nm thick) of $LaSrMnO_3$, along with a thermal image of the actual device with an in plane thermal gradient ∇Tx. The two thermometers are Pt resistances deposited by optical lithography.

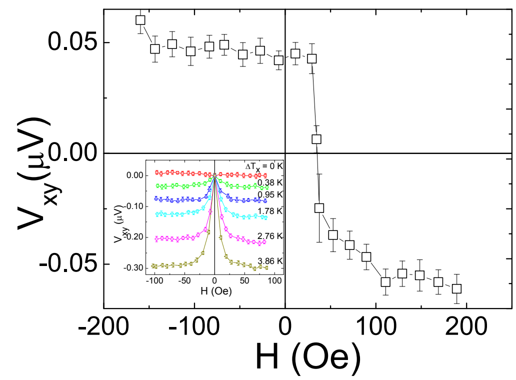

Figure 2. Field dependence of the transverse voltage Vxy for a temperature gradient across the plane ∇Tz of only 2 μK. The inset demonstrates the sub 0.1 resolution for in-plane thermal gradients, ∇Tx.

Inventors

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Relevant publications

- Anomalous and planar Nernst effects in thin films of the half-metallic ferromagnet $La_{2/3}Sr_{1/3}MnO_3$. Cong Tinh Bui and F. Rivadulla. *Phys. Rev. B 90, 100403(R)*, September 2014.

IP rights

- Spanish patent application. Priority date August 2014.

Type of collaboration

- License agreement
- Technical assistance
- Cooperative research projects

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