Israel Tech Transfer Network

Highly Sensitive Nanoscale Scanning Magnetic and Thermal Sensor (Yeda)
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Summary

A new technology developed by a group of researchers from the Weizmann Institute is a nanoscale sensor-on-tip for local magnetic signals and thermal dissipation with state-of-the-art sensitivity and spatial resolution. In light of the rapidly developing scanning-probe based technologies including nanomagnetism, spintronics, energy-efficient computing and quantum computing, there is a pertinent need for the development of nanoscale sensor devices for direct magnetic field and thermal imaging with high sensitivity and spatial resolution. To date, there are several local magnetic imaging methods, such as scanning superconducting quantum interference devices (SQUID), magnetic force microscopy and Lorentz microscopy. Scanning SQUID microscopy is a promising technology, having the highest field sensitivity (1 micro-Gauss), however, it has a rather poor spatial resolution (of several microns). Energy dissipation is another important imaging parameter, which is not readily measurable on the nanometer scale and existing thermal imaging methods are not sensitive enough for studying quantum systems and are unsuitable for low temperature operation. Here, we propose a novel sensor device comprising a nanoscale SQUID-based probe. The fabrication method, enables the miniaturization of the sensor to an effective diameter of 1 ?B/Hz1/2) and micro-Kelvin thermal resolution, whereas commercially available thermal scanning systems are limited to an order of 10 milli-Kelvin.

Applications

- Scanning probe microscopy for magnetic and thermal characterization
- Inspection and probing equipment for quantum computing.

Advantages

- Simple fabrication process
- High field sensitivity and bandwidth
- Nanoscale sensor (down to 46 nm in diameter)
- Tip-sample distance can be as small as a few nanometers
- 1 ?B/Hz1/2)
- High thermal resolution (

Technology's Essence

he present invention is a novel sensor device, based on nanoscale two-junction or multi-junction SQUIDs fabricated on the edge of a sharp tip in a three-dimensional geometric configuration. In such a setup, the SQUID can approach the sample to a distance of several nanometers. The small size of the sensor device and its ability to be placed at a short distance from the sample surface, result in extremely high sensitivity. The novel three-dimensional geometrical configuration of the SQUID-on-tip is obtained by focused ion beam milling, which enables measurement of both in-plane and out-of-plane components of the magnetic field with a remarkable sensitivity. The capability to measure in-plane fields enables use of this novel sensor device for applications such as in-plane spin detection and transport current distribution in complex systems. The unique nanoscale cross-section geometry of the device allows for non-contact, nanoscale-resolution sensing of the local temperature of a sample. This tool enables scanning cryogenic thermal sensing that is 4 orders of magnitude more sensitive than other devices, allowing for the detection of