Weak Magnetic Field Sensor Based on High-Temperature Superconductor Ceramic Material

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Weak magnetic field sensors with a resolution of δB<1 nT are developed on the basis of the magnetoresistive effect in high-temperature superconductor (HTS) ceramic thick films.[1] It is proposed to improve the resolution characteristics of the magnetic sensor by one or more orders of magnitude by controlled formation of infinite superconducting and normal open-pore clusters in the HTS ceramic structure. Special software is developed to determine fractal dimension D of the HTS ceramic structure based on the electron microscopy images.

The value of D for the infinite normal cluster is highly dependent on its shape and the HTS ceramics properties.[2] Given this fact determined is the optimal value of D corresponding to the maximum change of resistance within the range of magnetic field $B<|\pm 10|$ μT, which correlates to the magnetic sensitivity and other characteristics of the sensor. For example, at the optimal D for the sensor based on HTS ceramic thick film (a strip with dimensions: thickness $\sim$ 10μm, width $\sim$ 20μm, length $\sim$ 500μm) of Bi-2223 system with the operating temperature of 77 K it is possible to reach a resolution of $\delta B \leq 10$ pT.

[1]L.P. Ichkitidze. Physica C., V. 460-462, No. 2. P. 781-782 (2007).
[2]Y.I. Kuzmin. Technical Physics Letters, V. 36, No. 5. P. 400-403 (2010).