Superconducting Film Flux Transformer for Weak Magnetic Field Sensor

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The superconducting film flux transformers (SFFT) with high gain factors enable to significantly increase the magnetic sensitivity and thus the performance of weak magnetic field sensors (WMFS).[1] Examined is the geometry of WMFS comprising a magnetosensitive element (ME) based on the giant magnetoresistance effect when ME is separated by the dielectric layer from the narrow SFFT active strip above. SFFT active strip is nanostructured in the form of parallel branches with nanometer widths. It is proposed to maximize the SFFT gain factor growth F_m by varying the widths of the slits and branches, their number and topological location, and the SFFT material characteristics. The search for the optimal splitting of SFFT active strip into parallel branches, corresponding to the maximum value of F_m for a given configuration, examines the magnetic fields on ME created by superconducting currents in the branches, allowing for the non-uniform currents distribution and total branches inductance.
As an example of a particular SFFT configuration: the critical current density of 10^6 A/cm^2, the London penetration depth of 50 nm, the SFFT active strip width of 7000 nm and thickness of 150 nm, the minimum slits width of 80 nm. In the given configuration the optimal SFFT active strip splitting corresponds to the value of $F_m \approx 100$.

[1]Pannetier M., Fermon C., Le Goff G., Simola J., Kerr E., Science, **304**, 1648-1650 (2004).