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Abstract

Possibility Noninvasive Detection Magnetic Particles in Biological Objects †

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Abstract: We evaluated the minimum concentration and minimum size within which magnetic particles (MPs) can be detected by modern ultra-sensitive magnetic field sensors (MFS). Calculations showed that magnetite MPs with specific magnetization with characteristic sizes of $\geq$50 nm and a concentration of C_V~0.1 vol.% can be detected at a distance of $l \leq 0.1$ mm using MFS with a magnetic field resolution of $S_B \geq 1$ nT. However, at such a close distance it is impossible to non-invasively approach the biological object of study. On the other hand, the same MPs are easily detected at $l \leq 30$ mm using supersensitive MFS based on the phenomena of superconductivity (SQUID) or superconductivity and spintronics (combined MFS (CMFS)). These sensors require cryogenic operating temperatures (4–77 K), and S_B~10–100 fT are realized within them. Note that superparamagnetic particles or carbon nanotubes (CNTs) can also be non-invasively detected by SQUID or CMFS sensors, assuming that their concentration in the material is $C_V \geq 0.0000001$ vol.%. It is believed that CNTs may contain catalytic iron particles or encapsulated magnetic nanoparticles in nanotubes. Thus, modern supersensitive magnetic field sensors with $S_B \leq 100$ fT make it possible to detect MPs in nanoscale, submicron, and micron sizes in biological objects. They can be used for the noninvasive control of organs, implants, prostheses and drug carriers in the necessary parts of the body. Of particular importance is the noninvasive control of CNTs in functional biocompatible nanomaterials, which have good prospects for widespread use in medical practice.

Keywords: magnetic particles; magnetic field sensor; magnetic field resolution; carbon nanotubes

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