

Abstract

Possibility Non-Invasive Detection Magnetic Particles in Biological Objects [†]

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Abstract: We evaluated the minimum concentration and minimum size of magnetic particles (MPs) within which modern ultra-sensitive magnetic field sensors (MFS) can detect them. Calculations showed that magnetite MPs with specific magnetization with characteristic sizes of ≥ 50 nm and a concentration of CV ~ 0.1 vol.% Can be detected at a distance $l \leq 0.1$ mm using MFS with a magnetic field resolution of SB ≥ 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 SB ~ 10 –100 fT are realized in 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 CV ≥ 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 SB ≤ 100 fT make it possible to detect MPs in nanoscale, submicron, and micron sizes in biological objects. They can be used for non-invasive control of organs, implants, prostheses and drug carriers in the necessary parts of the body. Particularly important is the non-invasive 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