proceedings

Possibility Non-invasive Detection Magnetic Particles in Biological Objects

Levan Ichkitidze [1,2*], **Mikhail Belodedov** [3], **Alexander Gerasimenko** [1,2], **Dmitry Telyshev** [1,2], **Sergei Selishchev** [2]

[1] Institute for Bionic Technologies and Engineering of I.M. Sechenov First Moscow State Medical University, Moscow, 119991 Russian Federation

[2] Institute of Biomedical Systems of National Research University of Electronic Technology "MIET", Zelenograd, Moscow, 124498 Russian Federation

[3] Bauman Moscow State Technical University, Moscow, 105005 Russian Federation

* Correspondence: ichkitidze@bms.zone

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 C_V ~ 0.1 vol.% Can be detected at a distance $l \leq 0.1$ mm using MFS with a magnetic field resolution of S_B ≥1nT. 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 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 $C_V \geq$ 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 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.