QD04

SQUID System for Magnetically Labeled Immunoassay

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With the unique merit as the most sensitive sensor for magnetic signals, superconducting quantum interference devices (SQUIDs) are very useful to detect very weak magnetic signals. In this work, we developed a SQUID system for magnetically labeled immunoassay. When magnetic nanoparticles coated with bio-probes are mixed with samples having bio-targets, the magnetic nanoparticles become clustered. Thus, when an ac magnetic field was applied, the ac magnetic susceptibility of the samples is reduced due to the formation of clustered magnetic nanoparticles. SQUID system developed here is applied to detect the reduction in the ac magnetic susceptibility to probe tiny amounts of bio-targets. To enhance the sensitivity of the SQUID system, the technology associated with transfer coils is used. An example on assaying c-reactive protein is given to demonstrate the validity of the SQUID system for immunoassay. The results show that the sensitivity can be down to 10-20 mole of c-reactive protein.

QD05

Bio-magnetic separation combined with spectroscopy of intensity fluctuations of superparamagnetic, paramagnetic and diamagnetic nano-structures containing DNA- or iron-protein complexes

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To detect biomagnetic characteristics of living systems, the movements of microobjects and their dynamic properties were investigated using analytical magnetic separation analyses and spectroscopy of intensity fluctuations. Bio-rhythms of cardiomyocytes for isolated rat heart fragments, and bacteria, actin complexes were obtained in ultra-low-frequency measurements of Fourier-spectra and real-time characteristics. Magnetic susceptibility of single biological cells, particles and their aggregates for super-paramagnetic ferritin, paramagnetic methemoglobin and diamagnetic DNA nanostructures were determined in magnetic capture measurements. It was really possible to determine the magnetic susceptibility shifts up to $0.7 \cdot 10^{-10}$. Super-paramagnetic-ferrimagnetic clusters arising from ferritin cores were found in cultivated connective tissue by corresponding magnetic separation measurements. DNA-chromatin particles formed liquid-crystalline structures in separation. Micro-vibrations of tissue nano-crystals were detected in pulsating magnetic field (0.01-0.5 T, 0.5-4 Hz). In the method of spectroscopy of intensity fluctuations the frequency and magnitude of light intensity fluctuations of the speckle image were converted to a photocurrent (Fig. 1). The motility events counted every second were documented on a 6-graphs display indicating dependencies of frequency, temperature, amplitude, intensity versus time and Fourier-spectrum. The high-gradient magnetic separation (HGMS) method showed the concentration process of macromolecules of nucleoprotein, ferritin, and blood cells. The external steady magnetic field created by the structure of permanent pieces containing the "open domain boundary" is presented in Fig. 2. The distribution of magnetic field intensity was simulated according to the equation: $H(x/a) \sim 4M_r \ln(\text{cotan}x/a)$, where a is the length of a single permanent magnet piece. The movement of single particles was observed using a microscopy system combined with a CCD camera. Biorhythms of rat heart fresh cells showed immediately oscillations with narrow frequency bands at 46.85 Hz (Fourier-spectra) and acute real-time picture (Fig.3, a, b). After 10 min. of magnetic exposure 0.1 T this rhythm changed with the appearance of double band (Fig.3, c, d). Magnetic vibrations of micro-objects always occur in an organism under even weak magnetic fields, which penetrate inside the body almost without distortion. Magnetic and dynamical measurements will be useful for medicine nanotechnology.

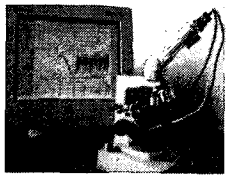

Fig. 1. Portable photodetector of micro-dynamics.

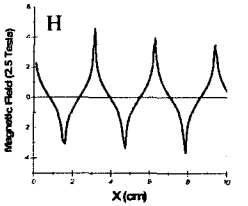

Fig. 2. Simulated field distribution.

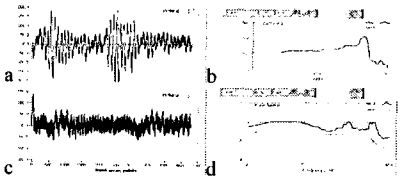

Fig. 3. Live (a,b) and stopping (c,d) detected bio-rhythms of rat heart cardiomyocytes.

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