Title of Project : Development of Advanced Biosensing Systems Utilizing Magnetic Markers and Magnetic Sensors

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【Purpose and Background of the Research】

Magnetic markers consisting of polymer-coated magnetic nanoparticles have been widely studied for biomedical applications. In this research, we will develop a magnetic biosensing system by using the magnetic markers and highly sensitive magnetometers. This magnetic-detection method is expected to have many advantages compared to conventional ones, such as high sensitivity and new detection function. First, we will improve key factors for this magnetic method, such as magnetic marker, sensor system and detection method. Then, we will develop detection systems for in-vitro and in-vivo diagnosis, and demonstrate the usefulness of the magnetic method.

【Research Methods】

Figure 1 shows research method for developing the biosensing system utilizing magnetic markers. We will study following topics.

1. We will develop a method to quantitatively characterize magnetic properties of the marker for biosensing application. They include harmonic spectra, hysteresis and magnetic relaxation. These results are used to select markers suitable for biosensing applications.
2. We will develop a highly sensitive sensor system and measurement method in order to detect a very small quantity of magnetic markers. They will be optimized depending on the properties of the magnetic markers.
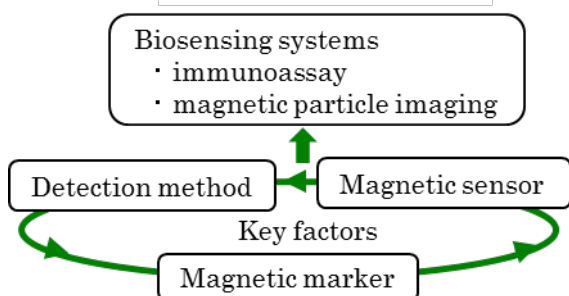3. We will develop two biosensing systems. One is

Fig. 1. Magnetic biosensing

a magnetic immunoassay system to detect disease related proteins for in-vitro diagnosis.

The other is the magnetic particle imaging for in-vivo diagnosis. In this system, the position and quantity of the magnetic markers that are accumulated inside the human body will be detected by measuring the filed map on the surface of the body.

【Expected Research Achievements and Scientific Significance】

We will establish the characterization method for magnetic properties of the magnetic markers. This method can be widely used in developing high performance magnetic markers for biosensing applications.

We will also achieve several methods in order to solve key issues for the development of magnetic biosensing systems. By improving the performance of the magnetic method, we will demonstrate several merits of the magnetic method, compared to conventional ones. These results enable us to realize next generation biomedical systems.

【Publications Relevant to the Project】

・ T. Yoshida et al, "Characterization of magnetically fractionated nanoparticles for magnetic particle imaging", J. Appl. Phys. vol. 114, 173908 (2013).
・ S. Uchida et al, "Highly sensitive liquid-phase detection of biological targets with magnetic markers and high Tc SQUID", IEEE Trans. Appl. Supercond. vol. 24, 1600105 (2014).
・ S. Bai et al, "Magnetic particle imaging utilizing orthogonal gradient field and third-harmonic signal detection", IEEE Trans. Magn., vol. 50, 5101304 (2014).

【Term of Project】 FY2015-2019

【Budget Allocation】 131,200 Thousand Yen

【Homepage Address and Other Contact Information】
http://www.sc.kyushu-u.ac.jp/~enlab/