【Grant-in-Aid for Scientific Research(S)】

Integrated Science and Innovative Science (New multidisciplinary fields)

# Title of Project : Development of the spin polarization pulsed EM, and application to nano-spin analysis

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Research Area : New interdisciplinary area

Keyword : Nano structure science

## 【Purpose and Background of the Research】

The severe demand for high-density of magnetic recording equipment in recent years makes it indispensable to set a magnetic record unit to 5nm or less, and exact evaluation of the high-manufacturing and the magnetic state of the magnetic quantum dots corresponding to the unit is demanded. Moreover, device-development where man controls and moves the magnetic moment of a spin or nm size is also contained in the view of next-generation technology development so that it may be represented by “Spintronics”.

In this research, the high resolution EM which uses the spin polarized electrons is developed for the first time in the world. The spin structure of nano size magnetic quantum dots, such as FePt dots developing for next-generation mass-HDD, and the magnetization reversal phenomenon in a tunnel magnetic resistance (TMR) element are studied extensively. Furthermore, in the stage which reaches the atomic level, the instrument visualizes the interface spin structure which governs the basic performance of various spintronics devices and uses for development of new nano-spin analysis technology.

## 【Research Methods】

This study advances researches in the following plans for five years in order to develop the first instrument and a measurement method in the world.

This research divides into the following seven portions, and is carrying out the research and development.

(1)Development of high-brightness and highly polarized electron photo cathods (2)Development of 20-50keV polarized electron gun (3) Development of spin rotation instrument, and of the incidence optimization design to EM (4) Development of the sample holder for electric field excitation, and an object lens part, the high sensitivity and the high precision recording method of the image (5) Development of the image-processing equipment which takes out a magnetic state, the magnetic relation of thin films (6) Versatility, and nano wire particulates and observation, (7)Theoretical research of scattering of electrons in magnetic potential by the spin.

## 【Expected Research Achievements and Scientific Significance】

The special features of this research are carrying the normal temperature operation possibility of, 90% or more spin-polarized electron gun beyond luminosity 2 x $10^7$ A/$m^2$sr in EM with 20-50kV accelerating voltage, and visualizing the magnetic state of nano materials in an atomic level. Moreover, since this electron gun carries out excitation operation by a laser pulse, EM of micro-second time resolution and the experiment of dynamic electron diffraction are also realized automatically.

Moreover, it is also the special feature that the first experiment can be conducted in the world which visualizes the magnetic moment in connection with the basis of the magnetism, in which not only equipment study of development but also study of the spin state in applied device elements are preformed.

While giving a big impact to the electron microscopy and physical science in the world, it is expectable to become research and development of resuscitation of our country which had exceeded the point to the western countries, or materials science in which this research did not succeed until now.

## 【Publications Relevant to the Project】

- N. Yamamoto, et al., "High brightness and high polarization electron source using transmission photocathode with GaAs-GaAsP superlattice layer", Journal of Applied Physics vol.103, and No.6 (2008) 064905.
- S. Fukami, N.Tanaka, T.Shimatsu, and O.Kitakami, "Nanostructure of CoPtSiO2 granular films for magnetic recording media", and Materials Transactions, Vol.46 and No.8 (2005) pp.1 to 5.

【Term of Project】 FY2009-2013

【Budget Allocation】 160,200 Thousand Yen

【 Homepage Address and Other Contact Information】

http://sirius.cirse.nagoya-u.ac.jp/%7Etanakalab/