Title of Project : Imaging of Crystal Textural Structure and Physical Values of Materials and Fields by Pulsed Neutrons

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Research Area : Nuclear Engineering
Keyword : Radiation, Neutron, Imaging, Crystal texture structure, Magnetic field,

【Purpose and Background of the Research】

It has been revealed that energy resolved imaging using a pulsed neutron source can give information on strain, preferred orientation, crystallite size as well as elements, and also information on magnetic field and magnetic domain for a bulk material as a real space image. Only neutron can give such physical values in a nondestructive way. This method is expected to be very useful for evaluation and development of materials and to be applicable to various fields. In this project we intend to develop the technology components for advancing this method, and establish it as a practical method. After then, we promote advanced applications.

【Research Methods】

A pulsed neutron source produces various energy neutrons in pulsed nature. We can analyze neutron velocity (energy) by using the time-of-flight method, in which arrival time of the neutron is measured at a certain distance from the source. The interaction of the neutron with a material (neutron cross section) depends on the neutron energy. As shown in Fig. 1 at a high energy region resonance peaks appear, which are peculiar to an element. As in the finger print we can identify the name, evaluate the amount of the element in the material, and measure the temperature by analyzing the peak width. On the other hand at a low energy region knurlings appear which correspond to the crystal structure. Information on crystallite size, preferred orientation and strain is deduced from this. In the case of hydrogenous materials, the neutron cross section increases with velocity, and the gradient is larger for the weak bounded one. Furthermore, the neutron is a small magnet, interacts with magnetic field, and gives the information on the magnetic field.

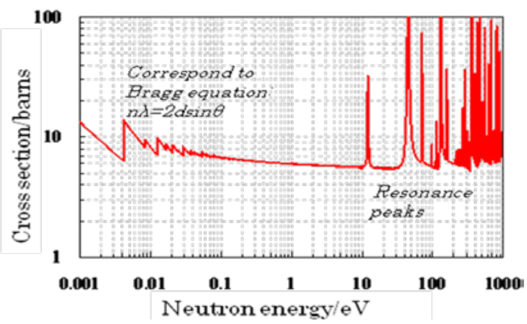

Fig. 1 Neutron cross section

In the pulsed neutron transmission coupled with the time-of-flight method, the energy dependent transmission can obtained for a wide area at once. By analyzing this kind of data we deduced, for example, the strain and the crystallite size as shown in Fig. 2.

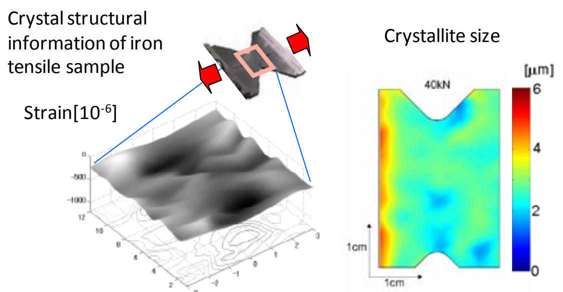

Fig. 2 Strain (left side) and crystallite size (right) in an iron tensile sample.

【Expected Research Achievements and Scientific Significance】

We will build up a nondestructive evaluation method for investigating the bulk material characteristics by expanding the applicability of the analysis code, developing the quantitative evaluation of the magnetic field and so on. Furthermore, we will apply this method to structural materials, hydrogen energy system, magnetic devices, antiques such as Japanese swords, which will contribute to highly reliable products, energy-saving society and culture.

【Publications Relevant to the Project】

H. Sato, T. Kamiyama and Y. Kiyanagi, A Rietveld-Type Analysis Code for a Pulsed Neutron Bragg-Edge Transmission Imaging and Quantitative Evaluation of Texture and Microstructure of a Welded Iron, *Materials Transactions*, **52,** 1294-1302(2011).

【Term of Project】 FY2011-2015

【Budget Allocation】 204, 400 Thousand Yen

【Homepage Address and Other Contact Information】

http://toybox.qe.eng.hokudai.ac.jp/about.html