

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

Integrated Science and Innovative Science (New multidisciplinary fields)



Title of Project : Development of Advanced Mössbauer Spectroscopy for Isotope Specific Analysis of Local State

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Research Area : New multidisciplinary fields

Keyword : Mössbauer spectroscopy, Nuclear probe, Synchrotron radiation, Isotope specific analysis

【Purpose and Background of the Research】

In Mössbauer spectroscopy, isotope-specific electronic states can be obtained by measuring the shift and/or split of the nuclear energy levels caused by the electron systems. So far, Mössbauer spectroscopy has been performed with radio isotope sources. In addition, synchrotron radiation sources extend the possibility of measurements, such as measurements of tiny samples. Moreover, energy tunable synchrotron radiation enables the nuclear resonant inelastic scattering measurements, and it offers the information on isotope-specific dynamics. We develop and establish advanced Mössbauer and nuclear resonant scattering spectroscopy. Taking advantage of the spectroscopy, we will perform leading studies such as the relation between local electronic states and macroscopic properties.

【Research Methods】

For the multi-element Mössbauer spectroscopy, we develop Mössbauer absorption spectroscopy with synchrotron radiation (Figure 1). Moreover, we develop grazing incidence and imaging Mössbauer spectroscopy. In addition, we improve Mössbauer spectroscopy with short-lived radio isotope sources. These will be used to study the local state of an arbitrary position in a sample with atomic resolution (Figure 2).

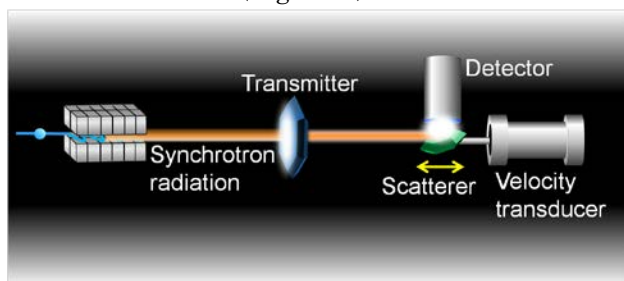


Figure 1. Schematic of Mössbauer absorption spectroscopy using synchrotron radiation.

【Expected Research Achievements and Scientific Significance】

Isotope substitution allows unique measurements in Mössbauer and nuclear resonant scattering

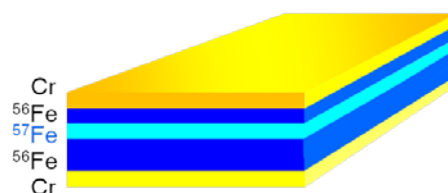


Figure 2. A Fe-Cr multi-layer with isotopic substitution of Mössbauer isotope ^{57}Fe .

spectroscopy. Furthermore, synchrotron radiation generates a small beam, and it realizes measurements under extreme conditions. Therefore, developed spectroscopy is expected to evolve material science, biological science, geosciences, etc.

【Publications Relevant to the Project】

- M. Seto, R. Masuda, S. Higashitaniguchi, S. Kitao, Y. Kobayashi, C. Inaba, T. Mitsui and Y. Yoda, "Synchrotron-Radiation-Based Mössbauer Spectroscopy", *Phys. Rev. Lett.*, **102** (2009) 217602-1-4.
- M. Seto, S. Kitao, Y. Kobayashi, R. Haruki, Y. Yoda, T. Mitsui and T. Ishikawa, "Site-Specific Phonon Density of States Discerned Using Electronic States", *Phys. Rev. Lett.*, **91** (2003) 185505-1-4.
- T. Mitsui, R. Masuda, M. Seto, E. Suharyadi, and K. Mibu, "Grazing-Incidence Synchrotron-Radiation ^{57}Fe -Mössbauer Spectroscopy Using Nuclear Bragg Monochromator and its Application to the study of Magnetic Thin Films", *J. Synchrotron Rad.*, **19** (2012) 198-204.

【Term of Project】 FY2012-2016

【Budget Allocation】 74,000 Thousand Yen

【Homepage Address and Other Contact Information】

<http://www.rri.kyoto-u.ac.jp/NRP/index.htm>