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RCNP EXPERIMENT E

PROPOSAL FOR EXPERIMENT AT RCNP

12 January 2010

TITLE:
A beam study for ^{57}Mn Mössbauer sepctroscopy

SPOKESPERSON:

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EXPERIMENTAL GROUP:

Full Name	Institution	Title or Position
Yasuhiro YAMADA	Department of Chemistry, Tokyo University of Science	Professor
Wataru SATO	Department of Chemistry, Kanazawa University	Associate Professor
Yoshio KOBAYASHI	RIKEN	Senior Researcher
Mototsugu MIHARA	Department of Physics, Osaka University	Assistant Professor
Takashi NAGATOMO	International Christian University	Research Associate

RUNNING TIME:

Installation time without beam	1 day(for each beam time)
Development of device	0 day
Test running time for experiment	2 days
Data runs	2 days

BEAM LINE: Ring : EN course

BEAM REQUIREMENTS:

Type of particle	^{58}Fe
Beam energy	$60A$ MeV
Beam intensity	$\geq$ 100 pnA
Any other requirements	NA

BUDGET:

Travel expenses	200,000 yen
Total	200,000 yen

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SUMMARY OF THE PROPOSAL

A radioactive isotope beam (RI-beam) produced as a secondary beam after projectile fragmentation of nuclei is becoming very attractive in materials science research. The combined on-line technique of the ion implantation using energetic RI-beam and Mössbauer spectroscopy has unique features in contrast to conventional implantation Mössbauer effect studies. For instance, in the case of ^{57}Mn which decays to ^{57}Fe with a half-life of 1.45 min, Mössbauer measurements provide information of the chemical state, magnetic and electric environment of the probe nuclei. We have succeeded in obtaining the well-resolved Mössbauer spectra of ^{57}Fe in Si, $KMnO_4$, solid oxygen, MgO etc. in order to investigate the ultimately dilute impurity Fe state in solids, and the novel reaction products of the extremely highly excited atomic state after nuclear events. We expect to start a new ^{57}Mn Mössbauer spectroscopic study at RCNP after establishing the ^{57}Mn beam.

We set up and have been using an elaborate chemical apparatuses and measurement system of ^{57}Mn Mössbauer spectroscopy in RIKEN for the research of chemical reactions of substances, e.g. solid oxygen. Unfortunately, the available beamtime is quite limited and we have little time to conduct other research projects, e.g. solid state material science, by ^{57}Mn Mössbauer spectroscopy at RIKEN. Since the study on the dilute transition metal impurities in metal oxides has been attracting a lot of interest and in the competition in material science, we started a new ^{57}Mn Mössbauer project at HIMAC two years ago and succeeded in obtaining spectra of good quality for materials comprising of low atomic number (low Z) elements. Materials with more interest, e.g., ZnO, $CaMnO_3$, have high attenuation coefficients to 14.4 keV Mössbauer γ-ray and it has been revealed that they cannot be used as a sample at HIMAC because the implantation energy of HIMAC is too high to control and stop the probe nuclei densely near the surface of the sample in order to measure the Mössbauer γ-ray of energy as low as 14.4 keV.

Thus, our intention is to conduct material science studies at RCNP by ^{57}Mn Mössbauer spectroscopy with the use of the accelerator which provides secondary ions with appropriate implantation energy for high Z material study. Before starting material studies, as a first step **we plan to carry out a study of the ^{57}Mn beam produced from ^{58}Fe to check the yield and quality of the beam.** We have experience in beam studies and measurement of the Mössbauer γ-ray, and are ready to start an experiment.