Spring-8 Experiment Report Format

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Beamline No:BL09XU

Experiment Title: Study of vibrational dynamics in transition metal-metalloid, metallic glasses.

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A beamtime of 3 shifts was allotted on the beamline BL09XU of Spring-8 for the study of vibrational dynamics in transition metal-metalloid, metallic glasses. This beam time was utilised to do the inelastic nuclear resonance scattering on a set of amorphous and crystalline alloys of composition $Fe_{80}B_{20}$. The specimens were prepared at IUC-DAEF with an enrichment of about 25% ^{57}Fe. This enrichment is necessary in order to enhance the signal because nuclear resonance scattering takes place only with ^{57}Fe isotope.

The experiment was performed in collaboration with Dr. T. Harami (JASRI), Dr. Y. Yoda (Tokyo University) and Dr. M. Seto (Kyoto University). Besides the beamtime, the necessary APD detector along with the fast electronic were provided by the Japanese collaborators. During my experiment the machine was operated in a 3x21 bunch mode. The high resolution monochromator was adjusted to give energy resolution of about 2.5 meV. Energy scans were taking for both amorphous as well as crystalline samples to determine cross section for inelastic nuclear resonance scattering as a function of photon energy. The photons scattered by the samples were detected at an angle of 90° from the direction of the incident beam in order to reduce the background due to electronic scattering. Further, first 5 ns after each radiation pulse were electronically filtered in order to remove most of the background due to prompt electronic scattering. Because of the limited enrichment, the signal was relatively weak however the beam time was sufficient to accumulate the data with good statistics on both the samples. The raw inelastic nuclear resonance scattering data was analysed to remove the multi phonon contributions and then was used to determine the partial density of states of Fe. The density of states of crystallised samples shows two peaked function typical of BCC crystalline lattice. The results on the density of states the amorphous alloy are very interesting as one observed a marked difference in the density of states as compared to the crystalline alloy of the same composition. In case of amorphous specimen an enhanced density of states are observed in the lower energy range (5 meV to 20 meV). This enhanced density of states in the lower energy range is generally termed as Boson peak. The results are being interpreted in terms of the vibrational dynamics of metallic glasses.