

# Inelastic Nuclear Resonance Scattering from FeCl<sub>3</sub>-Graphite Intercalation Compounds

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## 1. Introduction

Graphite Intercalation Compounds (GICs) are typical layered materials. Several kinds of materials (intercalants) can be intercalated into graphite layers [1]. The stage number of a GIC is defined as the number of graphite layers between the intercalant layers. One of the most characteristic properties of GICs is that changes in the stage number make the physical properties, such as the lattice dynamics, vary. To date, although the lattice dynamics of intercalants is essential to the staging mechanism, most attention has been paid only to the lattice dynamics of the graphite layers.

Inelastic nuclear resonant scattering is a useful technique for studies on element-specific phonon modes [2]. In this method, we can extract the phonon modes of intercalants. The angular dependence of the phonon modes for anisotropic samples can be studied by using a low-emittance x-ray beam [3].

## 2. Experimental

A stage-1 FeCl<sub>3</sub>-GIC was prepared by heating a piece of highly-oriented pyrolytic graphite and commercial FeCl<sub>3</sub> in an evacuated ampul for one week at 300 °C. The x-ray from the BL09XU beamline of SPring-8 was monochromatized by Si(1,1,1) double crystals and Si(4,2,2)-Si(12,2,2) nested crystals. Therefore, the x-ray was tuned to the 14.4-keV resonance of <sup>57</sup>Fe with an energy-width of about 6 meV. The measurement was done at 298 K.

The inelastic nuclear resonance scattering of the GIC was measured in two arrangements: the x-ray being parallel to the graphite layers (setting 1) and the x-ray being perpendicular to the graphite layers

(setting 2).

## 3. Results and Discussion

The obtained energy spectra, shown in Fig. 1, have inelastic shoulders at both side of an elastic peak. These shoulder-like phonon modes are found in a higher energy region in setting 2 than in setting 1. That is, the iron in the GIC vibrates more easily along the graphite layers than perpendicular to the graphite layers.

Since FeCl<sub>3</sub>-GICs have a small recoilless fraction at 298 K, the observed spectra include a large amount of multi-phonon contribution, which makes the spectra complex [4]. To promote this study, experiments at lower temperatures with a higher energy resolution, by using <sup>57</sup>Fe-enriched samples, are being planned.

## References

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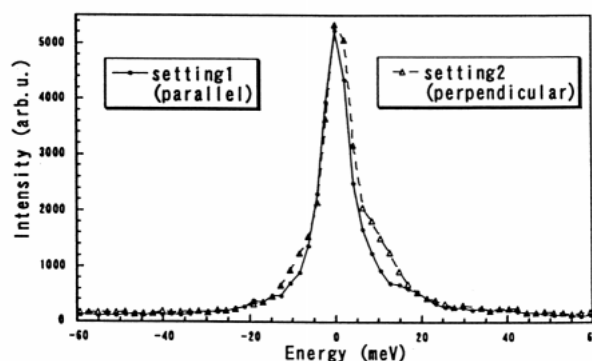


Fig. 1. Inelastic nuclear resonance scattering of a stage-1 FeCl<sub>3</sub>-GIC at 298 K.