

実験報告書様式(一般利用課題・成果公開利用)

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 MLF Experimental Report	提出日 Date of Report 2015.03.27
課題番号 Project No. 2014B0217 実験課題名 Title of experiment Search for high energy excitation of the crystal field ground state in Kondo semiconductor alloy system $\text{Yb}_{1-x}\text{R}_x\text{B}_{12}$ (R=Sc, Zr) 実験責任者名 Name of principal investigator Fumitoshi Iga 所属 Affiliation Ibaraki University	装置責任者 Name of responsible person Shinichi Itoh 装置名 Name of Instrument/(BL No.) HRC(BL-12) 実施日 Date of Experiment 2014.12.16-2014.12.22

試料、実験方法、利用の結果得られた主なデータ、考察、結論等を、記述して下さい。(適宜、図表添付のこと)
Please report your samples, experimental method and results, discussion and conclusions. Please add figures and tables for better explanation.

1. 試料 Name of sample(s) and chemical formula, or compositions including physical form. Name of sample(s) and chemical formula: YbB_{12} , $\text{Yb}_{0.75}\text{Zr}_{0.25}\text{B}_{12}$ $a = b = c = 7.469, 7.455 \text{ \AA}$, $\alpha = \beta = \gamma = 90 \text{ degree}$ NaCl-type (Face-Centered Cubic) Space group : Fm3m Powder sample, harmless, Volume = 8 cc, 15 gram/each sample They are encapsulated in aluminum foils in Al-can

2. 実験方法及び結果 (実験がうまくいかなかった場合、その理由を記述してください。) Experimental method and results. If you failed to conduct experiment as planned, please describe reasons. Experimental method: inelastic neutron scattering by high resolution chopper spectrometer (TOF) Wave number: $Q=2\sim 4 \text{ \AA}^{-1}$ Incident energy: $E_i=53.14$ and 154 meV Chopper frequency: 550 Hz Temperature: Lowest temp($2\sim 3 \text{ K}$), 10 K , 50 K , 100 K , 150 K , 200 K , 300 K Pressure = 0.1 MPa , Field B = 0 T YbB_{12} was expected to show three magnetic scattering peaks at $15.5(\text{M}1)$, $22(\text{M}2)$, and $40(\text{M}3)$ below $T=100 \text{ K}$ as shown in previous research by Bouvet et al. Zr-doping effect in Kondo semiconductor YbB_{12} was expected to show some clarified energy shift to higher region because Kondo temperature T_K was shifted from 80 K (YbB_{12}) to 110 K ($\text{Yb}_{0.75}\text{Zr}_{0.25}\text{B}_{12}$).

2. 実験方法及び結果(つづき) Experimental method and results (continued)

The figures show inelastic spectra of YbB_{12} and $\text{Yb}_{0.75}\text{Zr}_{0.25}\text{B}_{12}$ at lowest temperature and 50 K.

No expected energy shifts by Zr-doping have been recognized.

- 1) M1 peaks at both samples were very sharp and its intensity dose not decrease as temperature increase from 4 K to 50 K.
- 2) M2 peaks at YbB_{12} and $\text{Yb}_{0.75}\text{Zr}_{0.25}\text{B}_{12}$ may correspond to Kondo singlet to excited magnetic state in Gamma-8 (Crystal electric field, CEF) ground state. Its intensity decreases by Zr-doping as well as that of M1 peak.
- 3) M3 at around 40 meV peak may correspond to be a excitation from Gamma-8 crystal field in Kondo semiconductor ground state to next CEF excited state (Gamma-6 or Gamma-7). However spectra form in $\text{Yb}_{0.75}\text{Zr}_{0.25}\text{B}_{12}$ largely changed compared to that of YbB_{12} .
- 4) Many peaks have been found at 50, 65, and 80 meV, in this experiment. Those may be result of coupling between magnon and phonon.
- 5) Further Zr-doping effect is necessary in $x=0.5$ and 0.75 .

As the dependence of Zr-content to the Kondo energy gap was measured, we will expect the origin of the Kondo semiconducting mechanism in YbB_{12} .

