Elastic properties in a cubic compound $PrRu_2In_2Zn_{18}$

R. Komatsu*, K. Wakiya*, M. Nakamura*, M. Yoshizawa* and Y. Nakanishi*

* Graduate School of Science and Engineering, Iwate University, Morioka, 020-8551, Japan
Email: g0322070@iwate-u.ac.jp

PrT_2X_{20} (T : Transition metal, X = Zn, Al) have attracted considerable attention because they exhibit various interesting phenomena arising from multipole degrees of freedom. The crystalline electric field (CEF) ground state of PrT_2X_{20} is a Non-Kramers Γ_3 doublet which has two kinds of multipoles, that is, quadrupole and octupole degrees of freedom. Among PrT_2X_{20}, $PrRu_2Zn_{20}$ shows a structural phase transition at T_S = 138 K [1]. The multipole degrees of freedom in $PrRu_2Zn_{20}$ is lifted by the structural phase transition. On the other hand, it recently reported that isostructural compound $PrRu_2Sn_2Zn_{18}$ in which Zn atoms at the 16c site in $PrRu_2Zn_{20}$ are fully replaced by Sn does not shows the structural transition. In $PrRu_2Sn_2Zn_{18}$, the multipole degrees of freedom is maintained even at low temperatures because the structural transition is suppressed by the Sn substitution [2]. More recently, it was reported that Zn atom at the 16c site can be replaced by not only Sn but also In. A Van-Vleck paramagnetic behavior in $PrRu_2In_2Zn_{18}$ is confirmed by its magnetic susceptibility measurement, indicating a possible Γ_3 doublet ground state [3].

In this study, we performed ultrasonic measurements on $PrRu_2In_2Zn_{18}$ to determine the CEF ground state. On cooling, the elastic modulus increases monotonically down to 100 K. In $PrRu_2Zn_{20}$, a softening of elastic modulus was observed at around T_S [1]. Therefore, the monotonically increase of elastic modulus indicates that the structural transition in $PrRu_2Zn_{20}$ is suppressed by In substitution. Below 10 K, the transverse elastic modulus exhibits a softening which can be explained based on the CEF model with a Γ_3 ground state.

[1] I. Ishii, et al. J. Phys. Conf. Ser. 273 012136 (2011).
[2] K. Wakiya, et al. J. Phys. Soc. Jpn. 87, 094706 (2018).
[3] T. Komagata, et al. JPS Conf. Proc. 30, 011157 (2020).