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Valence fluctuation of $\text{YbFe}_4\text{Sb}_{12}$

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Magnetic and specific heat properties for five samples of $\text{YbFe}_4\text{Sb}_{12}$ prepared by several different methods have been investigated and compared to literature.[1-3] The quality of these samples was checked by X-ray powder diffractometer, and confirmed that the amount of impurity phases, Sb, FeSb_2 , YbSb_2 , Yb_2O_3 , is negligible. No trace of Fe crystal was detected at all in the powder-diffraction pattern.

Above 100 K, the inverse magnetic susceptibility χ^{-1} obeys the Curie-Weiss law. The effective Bohr magneton number, however, depends on the samples ranging from 3.65 to 9.91 μ_B , indicating that the origin of magnetism of this skutterudite $\text{YbFe}_4\text{Sb}_{12}$ is not only Yb atoms but also Fe atoms. The second feature of the magnetic properties is a plateau of $\chi(T)$ existing around 40 K, which becomes more clear for the samples having larger μ_{eff} . The third feature is a small ferromagnetism; T_c is 15.5, 11.4, ~ 10 K, and below 2 K for two samples, where we listed these in order of μ_{eff} . The residual magnetization is small, at most, 0.08 μ_B . The fourth feature is a tiny indication of T_N at 2 K, which is the lowest temperature in the present magnetization experiment, for some samples.

From the specific heat measurement, the minimum value of C/T is determined to be about 140 mJ/mol $\cdot\text{K}^2$ except for the sample with the smallest μ_{eff} . In this sample, a distinct λ -type anomaly of $C(T)$ has been observed at 2.0 K, and the entropy S accumulated from 0.5 K reaches about 50% of $R \ln 2$ including the tail up to 4.0 K. So, this anomaly is considered to be caused by the entropy of doublet (or quartet) ground state of Yb^{3+} in $\text{YbFe}_4\text{Sb}_{12}$, that is, this is not due to magnetic impurities.

We have observed new anomalous behaviors in $\text{YbFe}_4\text{Sb}_{12}$ depending on samples. Magnetic 3d electrons or itinerant 3d electrons in $\text{Fe}_4\text{Sb}_{12}$ polyanions appear to be sensitively affected and, maybe, correlated to the magnetism of Yb valence fluctuating. At the present time, however, the origin is not clear.

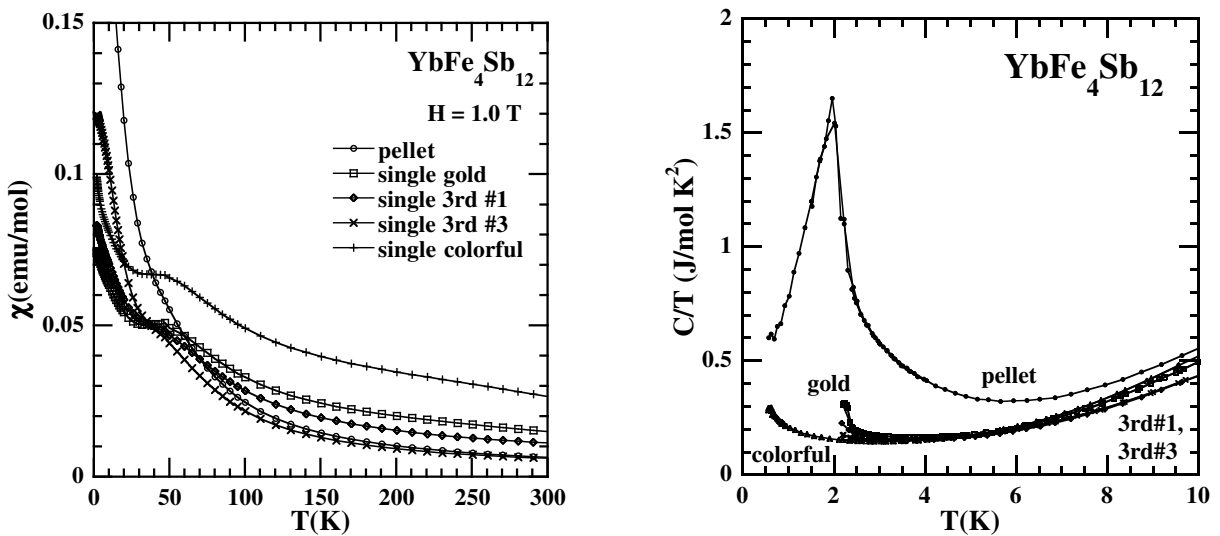


Figure 1: Magnetic susceptibility and specific heat of various samples of $\text{YbFe}_4\text{Sb}_{12}$

[1] N. D. Dilley et al., Phys. Rev. B **58** (1998) 6287.

[2] A. Leithe-Jasper et al., Solid State Commun. **109** (1999) 395.

[3] E. Bauer et al., Eur. Phys. J. B. **14** (2000) 483.