Accepted Manuscript

Anomalous rattling and single crystalline properties of the caged compound URu_2Al_{10}

R. Troć, M. Pasturel, M. Samsel-Czekała, R. Wawryk, Z. Gajek

PII: S0925-8388(18)30333-5

DOI: 10.1016/j.jallcom.2018.01.319

Reference: JALCOM 44783

To appear in: *Journal of Alloys and Compounds*

Received Date: 23 October 2017

Revised Date: 22 January 2018

Accepted Date: 25 January 2018

Please cite this article as: R. Troć, M. Pasturel, M. Samsel-Czekała, R. Wawryk, Z. Gajek, Anomalous rattling and single crystalline properties of the caged compound URu_2Al_{10}, *Journal of Alloys and Compounds* (2018), doi: 10.1016/j.jallcom.2018.01.319.

Anomalous rattling and single crystalline properties of the caged compound URu_2Al_{10}

R. Troć[1*], M. Pasturel[2], M. Samsel-Czekała[1], R. Wawryk[1] and Z. Gajek[1],

[1] *W. Trzebiatowski Institute of Low Temperature and Structure Research, Polish Academy of Sciences, Okólna 2, 50-422 Wrocław, Poland*

[2] *Institut des Sciences Chimiques de Rennes, Chimie du Solide et Matériaux, Université Rennes 1, UMR CNRS 6226, Campus de Beaulieu, 263 av. Général Leclerc, 35042 Rennes Cedex, France*

* Corresponding author: Tel.: +48 71 3954 206;
E-mail address: R.Troc@int.pan.wroc.pl (R. Troć)

ABSTRACT

We report on an experimental single-crystal study of URu_2Al_{10}, crystallizing in the $YbFe_2Al_{10}$ type orthorhombic structure, supplemented by the results of crystal field and band structure calculations. We investigated the magnetic, thermal and transport properties of this caged-type compound. Based on the local character of the $5f^2$−electron configuration of the U^{4+} ion in URu_2Al_{10}, the effective crystal field (CF) potential in the intermediate coupling form was estimated using the CF level scheme, composed only of singlets. This was carried out in a similar manner to that reported for UFe_2Al_{10} [Phys. Rev. B 92 (2015) 104427]. The obtained scheme satisfactorily reproduces both the magnetic susceptibility (measured along the three main crystallographic directions) and the Schottky-type anomaly of the specific heat. The latter was estimated using the specific heat data of $ThRu_2Al_{10}$ as a phonon reference. In addition, the strong anisotropic behavior of the Seebeck coefficient measured along the three principal directions, and its low-temperature pronounced maxima, have been approximately explained by the CF effect. The latter dominates in the S-shaped temperature dependencies of the electrical resistivity, measured using the current flowing along the three main axes. However, the magnetoresistivity reveals an anisotropic electronic structure that could originate from a *c-f* hybridization effect in an orthorhombic unit cell. This gives rise to the typical metallic character of URu_2Al_{10}, as is also the case for UFe_2Al_{10}. This behavior underlines the *dual* character of the 5*f*–electrons in these ternaries. In turn, the presence of low-frequency Einstein modes reflects the presence of regular rattling of the U^{4+} ion located in the $[Ru_4Al_{16}]$ cage. This rattling is, however, disturbed at low temperatures by applying an external magnetic field which causes strong scattering of the experimental electrical resistivity points. This effect is also anisotropic, as proved by a comparison of the resistivity results determined at zero and 9 T for a single-crystalline sample of URu_2Al_{10}. The above effect also exists for isostructural UFe_2Al_{10}, but its anisotropy is less apparent.

Keywords:
Actinide alloys and compounds; Heat capacity; Magnetoresistance; Electron-phonon interactions; Kondo effect; Electronic band structure