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MAGNETIC MEASUREMENTS OF THE
TRANSURANIUM ELEMENTS

Progress Report

January 1, 1986 - December 31, 1986

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MASTER

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PERSONNEL

During this time the principle investigator, S. E. Nave, devoted 100% of his time to the contract and will continue to do so during the remaining period of the contract.

Grant Employees:

1. S. E. Nave	12 months	100% effort
2. J. R. Moore	12 months	100% effort
3. R. C. Hart	9 months	20% effort
	3 months	100% effort

Collaborators

1. R. G. Haire, Chemistry Division, Oak Ridge National Laboratory (ORNL)
2. J. R. Peterson, Chemistry Department, University of Tennessee and Chemistry Division, ORNL
3. J. K. Gibson, Chemistry Division, Oak Ridge National Laboratory
4. Alain Blaise, Center for Nuclear Studies, Grenoble, France
5. G. Amoretti, Universita di Parma, Parma, Italy

Highlights of Research Progress

Trichlorides of Californium

Magnetic measurements have been made on polycrystalline CfCl_3 in both a hexagonal and orthorhombic crystal form. The magnetic properties were studied as a function of crystal structure by converting the same sample back and forth from one form to the other. The results indicated a larger crystal field splitting in the orthorhombic form (100K versus 60K) as well as a larger value for the Weiss constant (37K versus 13K). The effective moment value of $10.2\mu_B$ agrees with the theoretical intermediate coupling value for an f^7 configuration. Both types exhibited metamagnetic transitions below 15K, i.e., the behavior changed from antiferromagnetism to ferromagnetism as the field increased beyond a critical value.

Curium Bismuthides

In a continuation of a study of the magnetic transition temperature as a function of actinide-actinide separation of the curium pnictide series we have undertaken magnetic measurements on curium bismuthide during this contract period. The bismuthide has the largest radius and thus provides the greatest actinide-actinide separation of the series. It is of interest to see if the transition temperature of the bismuthide is higher than that of the antimonide as indicated by the increasing trend observed in going from the phosphide to the antimonide. Several different preparation conditions were used in an effort to obtain a pure phase sample. The temperature was varied, and reactions with both liquid and gaseous bismuth were tried. None of the preparations resulted in a sample free from second phases as indicated by weak, unindexed X-ray diffraction lines. The bulk lattice parameter was more in accord with the trend found in the rest of the series than a previously reported value that was anomalously low. For the eight samples subjected to magnetic measurements the behavior of the susceptibility versus temperature for all but one varied between two distinctly different curves with one following an intermediate curve. If we choose the type behavior that resembles that observed previously for the rest of the series, we can assign a transition temperature in accord with the trend. However, this hypersensitivity to minor phases means that it will be necessary to obtain single phase samples for magnetic measurements before the behavior of curium bismuthide can be fully understood.

Single-crystal Growth

We have accomplished several milestones in our program to grow single crystals of actinide metals and compounds and determine their solid-state properties. Previous physical property measurements on transamericium actinide materials have been mainly limited to polycrystalline samples due to the limited availability of materials and the great material losses incurred during the common crystal growth methods. We have investigated a low-loss, microscale technique of crystal growth using lanthanides as non-radioactive stand-ins for the radioactive actinides.

The first technique, modification of the moving-zone method, was used to successfully prepare single crystals of several lanthanide trihalides. A state-supported (Science Alliance Program) summer student helped develop a method of hermetically encapsulating these hygroscopic materials in a container that was sufficiently small to allow magnetic measurements as a function of orientation. Determination and orientation of the crystal axes were accomplished using the recently acquired x-ray precession camera. This student also succeeded in determining the susceptibility of NdCl_3 as a function of crystal orientation.

DISCLAIMER

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Publications

During this contract period the following peer-reviewed papers were published or accepted for publication:

- (1) "Magnetic Susceptibility of CfCl_3 and its Dependence on Crystal Structure", accepted for publication in the Journal of Less-Common Metals.
- (2) "Magnetic Studies of Transplutonium Actinides", accepted for publication in Handbook on the Physics and Chemistry of the Actinides, editors: A. J. Freeman, G. Lander, and C. Keller.

These papers follow this report.

In addition the following poster or oral presentations were made at the indicated conference:

- (1) 17th Rare Earth Research Conference, June 8-12, 1986, Hamilton, Canada

Poster: Magnetic Susceptibility of CfCl_3 and its Dependence on Crystal Structure

Presented by: S. E. Nave

Authors: S. E. Nave, J. R. Moore, J. R. Peterson, and R. G. Haire

- (2) 192nd ACS National Meeting, Sept. 7-12, 1986, Anaheim, California

Oral Presentation: Preparation and Solid State Properties of Curium Bismuthides

Presented by: J. K. Gibson

Authors: J. K. Gibson, R. G. Haire, S. E. Nave, and J. R. Moore

Abstracts of these presentations are attached.

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