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**Important New Insights into f-Electron Behavior Via
Ultra-high Pressure Studies of Transplutonium Elements.**

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*** Prefer oral presentation**

[Suggest session on Actinide Compounds and Complexes].

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Introduction

Over the past two decades there have been several studies to pursue the effects of pressure on the f elements and their compounds. One issue in such studies is to ascertain how the decreasing distances brought about by applying pressure affect the electronic nature of the materials. An especially important point is whether pressure can force involvement of the f-electrons in the bonding in cases where these electrons are normally delocalized. Whereas the elements from protactinium through plutonium are accepted as having f electron involvement in their bonding at ambient pressure and temperature, in contrast the transplutonium elements do not. Thus, one goal for investigating the transplutonium elements under pressure is to ascertain if pressure can force delocalization of their normally localized f electrons .

Monitoring the structural form of materials with pressure is one experimental approach used in probing the extent of involvement of the f electrons in bonding. Although this approach requires some interpretation of the structure-bonding relationships, it has the advantage that experimentally it is possible to reach very high pressures. The structure-bonding relationships for the 4f- and 5f-electron elements have been developed both experimentally and theoretically to the level that a high degree of confidence exists with regard to such interpretation.

There has been a continued advancement in the experimental arena, due to the development of new diamond anvil cell design, detectors and the application of synchrotron radiation. Authorization to study actinides more radioactive than uranium at synchrotron sites has also advanced greatly the understanding of the bonding present in these elements. Our recent results from studies of americium, americium-curium alloys and curium under pressure have provided new insights and a better understanding of the pressure behavior of these transplutonium elements in terms of their position in the actinide series. Reviews of earlier studies of these actinides and lanthanides under pressure have been published^{1,2}. There is strong evidence that the 4f-electrons of lanthanide elements in the first half of the 4f series do become delocalized under pressure. Cerium is an interesting and well-studied example, and a recent study³ employing synchrotron radiation has enabled important new facets to be established concerning its behavior with regard to actinide behavior under pressure.

We concentrate here on the behavior of americium metal under pressure. Some work on americium metal under pressure has been published previously^{1,2} but important aspects of its structural behavior up to moderate pressures have differed in these reports. The resistivity of this metal up to 25 GPa has also been discussed⁴ and provides information complimentary to that obtained from structural studies.

Americium occupies a pivotal position in the actinide series, displaying localized 5f-electron behavior while the four preceding members are recognized for their itinerant 5f-electron states. Important new insights into the nature of americium's 5f electrons with regard to metallic bonding and the relationship to that in plutonium have been acquired in our recent work. This work has employed modern pressure-cell designs, synchrotron radiation and an inert gas pressure-transmitting media. These have helped to provide superior resolution and intensity relationships, extended diffraction data and information for higher pressures.

As a result, we have also resolved the controversial findings reported earlier for americium in the 10-30 GPa region and have also addressed the significant difference noted between the magnitude of the theoretical and experimental relative volume collapse observed under pressure. In this recent work at ambient temperature, we found americium exhibits four different structure forms under pressure. The ambient pressure double hexagonal close packed structure first converts to a face centered cubic phase. The latter then changes to a cell having orthorhombic symmetry, which itself transforms with additional pressure to a second orthorhombic structure. The latter is stable up to one megabar. By correctly identifying the structural forms, it is also possible to establish the mechanism for the sequential conversion of the structures with pressure. A critical aspect provided by these new data is that a link can be made to the phases of plutonium.

These new findings will be presented and discussed in terms of our present understanding of the behavior of the transplutonium elements under pressure, which provides new insights for the pivotal position of americium in the series.

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