The Complexity of Plutonium Phase Stability as Revealed by Thermal Expansion

Jeremy N. Mitchell
Nuclear Materials Science Group
Los Alamos National Laboratory
Los Alamos, NM 87545

Plutonium is a remarkably complex element. It has six allotropic phases at ambient pressure and exhibits phase instability as functions of temperature, pressure, alloying, and age. The room temperature monoclinic α-phase is the most dense (19.8 g/cc), whereas the high-temperature, face-centered cubic δ-phase is the least dense (16 g/cc). Addition of as little as 1 atomic % of Ga or other Group IIIA elements will partially stabilize δ-Pu at room temperature, and Pu-Ga alloys have their own fascinating phase stability complexities. The instabilities and transformations of plutonium and its alloys correspond with dramatic changes in various thermophysical properties, including thermal expansion, heat capacity, resistivity, and elastic moduli. In this talk, I will present an overview of plutonium phase stability as revealed using dilatometry. This will include phase transformations in pure plutonium, alloying and stabilization of plutonium, and aging studies of plutonium alloys.