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Production and investigation of thin films of metal actinides (Pu, Am, Cm, Bk, Cf)

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Under limited availability of transplutonium metals special techniques and methods of their production have been developed that combine the process of metal reduction from a chemical compound and preparation of a sample for examination. In this situation the evaporation and condensation of metal onto substrate becomes the only possible technology.
Thin film samples of metal curium (244Cm, 248Cm) and 249Bk were produced by thermal reduction of oxides with thorium at ≈1700°C. Metal layers of 0.6-180 μm and 2.5 μm thickness, respectively, were deposited onto the tantalum substrate. For production of metal californium 249Cf in the form of a layer with a thickness of (2.4 ± 0.3) μm the method of thermal reduction of oxide with lanthanum was used.
Samples of 238Pu in the form of a film with a layer thickness between 1 and 40 μm and those of 239Pu with a layer thickness between 15 and 40 μm for X-ray structure analysis were prepared by direct high temperature evaporation and condensation of metal onto substrate. For production of 241Am sources a gram sample of plutonium was used containing about 18.5% of americium at the time of production.
Thermal decomposition of Pt5Am intermetallic (262 mg mass) in vacuum was used to produce metal americium with about 80% yield.
Resistivity of metal californium (249Cf) films with a thickness of (0.8 ≈ 0.1) and (0.1 ≈ 0.01) μm was measured using the potentiometric method. Initial resistivity values of samples 1 and 2 (5-6 hours after their production) made up (570 ≈ 80) and (9100 ≈ 1200) μOhm•cm, respectively. The resistivity of both film samples was found to decrease exponentially with increasing temperature. Negative temperature coefficient of resistivity achieved –(450 ≈ 22)•10-6 K-1 in the temperature range 77 –300 K.
The analysis of literature data on metal californium structure allowed an observation of a tendency to form the preferred DHCP structure with increasing sample mass. And, on the contrary, the smaller is the quantity of metal californium under examination, the higher is the probability of interpretation of X-ray diffraction analysis results based on FCC and HCP structures.
The performed study on the effect of high specific activity on the crystal structure of plutonium isotope (238Pu) thin layers showed an appearance of non-equilibrium (at room temperature) phases. However, many aspects of this observable phenomenon have not been investigated yet experimentally and comprehended theoretically.

Primary author: Prof. RADCHENKO, Viacheslav (JSC "State Scientific Center - Research Institute of Atomic Reactors")

Presenter: Prof. RADCHENKO, Viacheslav (JSC "State Scientific Center - Research Institute of Atomic Reactors")

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