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Radiographic examination of curium alloys with cobalt, iron, and carbon

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Over many years JSC "SSC RIAR" has been performing activities on the production and investigation of metals of transplutonium elements (TPE), their alloys and compounds.

This paper presents the results of production and radiographic examination of micro-samples of curium-244 compounds with iron, cobalt and carbon, namely an identification of crystal lattices of the compounds obtained and calculation of crystal lattice parameters, study on the effect of intensive alpha-decay on crystal structures of intermetallides and carbides.

Samples of the Cm-Co, Cm-Fe and Cm-C systems were prepared by high temperature condensation of metal curium vapor onto corresponding substrates. In the Cm-C sample such a "sub-strate" represents a thin amorphous carbon layer applied preliminary onto a flat iridium plate. The radiographic examination results of the produced compounds are presented in the table below.

Table

Crystal lattice parameters of phases detected during investigation of the Cm-Fe, Cm-Co and Cm-C systems.

System Phase Lattice Lattice parameters

a, Å c, Å V, Å³

Cm-Co Co₁₇Cm₂ Hexagonal (P6₃/mcm) 8,378(7) 8,070(5) 491(1)

Co₅Cm Hexagonal (P6/mmm) 4,88(1) 4,08(4) 84(1)

Co₂Cm Cubic (Fd3m) 7,242(2) - -

Cm-Fe Fe₁₇Cm₂ Hexagonal (P6₃/mmc) 8,406(3) 8,122(2) 497,0(5)

Fe₂Cm Cubic (Fd3m) 7,213(2) - -

Cm-C Cm₂C₃ Cubic ()

8,3904(5) - -

Cm₃C FCC 5,172(2) - -

Note. In the column "Lattice" a lattice spatial group is indicated in brackets. V – is volume of a crystal lattice elementary cell. Definition errors of the last character are given in brackets after the lattice parameter values.

In the Cm-Co system three intermetallic compounds were detected: Co₁₇Cm₂ (hexagonal lattice of spatial group P6₃/mcm), Co₅Cm (hexagonal lattice of spatial group P6/mmm) and intermetallic Co₂Cm (cubic lattice of spatial group Fd3m). Cadmium did not show any solubility in Co and Co-Cu at room and elevated temperature.

In the Cm-Fe system two intermetallic compounds were detected: Fe₁₇Cm₂ (hexagonal lattice of spatial group P6₃/mcm) and Fe₂Cm (cubic lattice of spatial group Fd3m). This system did not show mutual solubility of its components at room temperature. The effect of high alpha-activity of ²⁴⁴Cm nuclide on the crystal structure of intermetallide Fe₂Cm was demonstrated.

In the Cm-C system carbides Cm₂C₃ and Cm₃C with a cubic lattice were detected, which were isostructural with regard to carbides Am₂C₃ and Sm₃C. Crystal lattice parameters of the curium carbides were calculated and data on their x-ray amorphization induced by intensive ²⁴⁴Cm decay were obtained.

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