Thermodynamic properties of heterogeneous alloys of lanthanum with gallium-indium eutectic

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Abstract

Currently, much attention is paid to the development of nuclear energy, including the fast breeder reactors. Using of these reactors will significantly increase the fuel burnup and reproduction of fissile materials. Pyrochemical methods are developed for processing spent nuclear fuel (SNF) of such reactors. Some of them are based on the use of molten salt mixtures. The main advantage of these methods is the high radiation resistance of melts. For separation of fuel components can be used deposition processes at the liquid metal of fuel elements or fission products. To carry out these processes is necessary to know the behavior of all components of these systems, including lanthanum, which is one of the fission products.

It is known that the gallium is one of the most useful metals for separation of uranium and lanthanum. The main reasons for this behavior of gallium - it's high rates of partition coefficients of U and La (thermodynamic estimate shows that in the temperature range 800-1000 K it varies from $1,4 \cdot 10^4$ to $5 \cdot 10^5$, which is significantly higher than for other low-melting metals) . To lower the melting temperature of the metallic phase should use its alloys. The lowest melting temperature in systems based on gallium-served observed for the alloy Ga - In (Tm = 289 K). In addition, we must remember that the eutectic metal systems in their behavior tend to of an ideal, so the vapor pressure over melts of Ga-In can be estimated from the additivity rule and calculated at 1100 K, the equilibrium vapor pressure above the eutectic melt of Ga - In is $1,14 \cdot 10^7$ atm. The use of alloys of this composition would, inter alia, to reduce the operating temperature of components separating process of the spent nuclear fuel.

Thus, a wide range of liquid states and low vapor pressure in the Ga - In system favor the development of processing of spent nuclear fuel at low temperatures using data from bimetallic melts. Working with the spent fuel in such an environment will allow a substantial but to simplify the of deep fractionation of nuclear waste in the system "liquid chloride salt - the metal" to achieve a return of 99.9% in the cycle of nuclear materials and training programs to the final disposal of waste.

The selectivity of the separation process is influenced by both properties of metal and salt phases at the interface which, passing through the separation of the chemical elements. Therefore, to study the thermodynamic features of eutectic alloy Ga - In in processing of irradiated nuclear fuel is necessary to study the thermodynamic properties of all components of the fuel, as in metal-ray, and in salt melts. There are literature data of the lanthanum behavior in binary metallic systems with gallium and indium. Records of the thermodynamic properties of lanthanum in the three-component metallic systems, including those consisting of Ga and In

are not found, In the present study was an experimental determination of the lanthanum activity in the eutectic alloy Ga-In in the temperature range 573 1073 K using the EMF.

As a result of this work were first identified lanthanum activity in the eutectic alloy Ga-In in the range 573-1073 K. It is shown that the saturated two-phase systems of lanthanum in equilibrium with the liquid phase intermetallic compounds are $LaGa_6$ (750 K) and $LaGa_2$ (after 750 K). Clarified the thermodynamic characteristics of two-phase alloys of lanthanum with gallium and indium, and lanthanum with indium-floor chennye earlier in a narrow temperature range.