Isothermal section of the U-Fe-Ge ternary system at 900ºC

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Investigations on uranium-based ternary intermetallics continue to reveal new phases, with specific structures and rich variety of ground-state properties. In the U-Fe-Ge system the previously reported ternary intermetallic compounds were UFeGe ($P2_1/m$, type UFeGe below 500K, and *Pnma*, type TiNiSi above 500K) [1], UFe_2Ge_2 (*I4/mmm*, type $ThCr_2Si_2$) [2], UFe_6Ge_6 (*P6/mmm*, type $YbCo_6Ge_6$) [3], and the solid solution $U_2Fe_{17-x}Ge_x$ with $2<x<3$ ($P6_3/mmc$, type Th_2Ni_{17}) [4], in addition to the recently reported U_2Fe_3Ge compound ($P6_3/mmc$, type $MgZn_2$) [5, 6].
Following the previous work made on the U-Fe-Ge system [7], the aim of the present study is to complete the experimental investigation of the 900ºC isothermal section of the U-Fe-Ge phase diagram and the characterization of the new intermetallic compounds.
The samples were prepared by direct melting the calculated amounts of U, Fe and Ge elements (purity >99.9 mass%), in an arc-melting furnace and under high purity argon atmosphere, followed by annealing at 900ºC for one week inside evacuated quartz ampoules. The microstructure of all samples was analysed by SEM-EDS and the crystalline structure was characterized by powder and single-crystal X-ray diffraction.
The existence and composition of all the binary phases previously reported at 900ºC were confirmed and their crystal data are in agreement with literature. The binary compound UFe_2 is the only one existing in the U-Fe system at the studied temperature, and in this ternary system, there is a substitution of iron by germanium in an amount up to 6.7 at%, as solid solution $UFe_{2-x}Ge_x$. All the other binary phases have negligible solubility extensions into the ternary system at this temperature.
The isothermal section was found to be very rich: there are 13 stable phases at 900ºC. Among these, there are nine new intermetallic compounds: $U_{34}Fe_{4-x}Ge_{33}$, $UFe_{1-x}Ge_2$, $U_3Fe_2Ge_7$, $U_9Fe_7Ge_{24}$, U_2Fe_3Ge, $U_6Fe_{16}Ge_7$, $U_3Fe_4Ge_4$, UFe_4Ge_2 and $U_6Fe_{22}Ge_{13}$. Within these new phases, three are new original structural types: $U_{34}Fe_{4-x}Ge_{33}$ and $U_9Fe_7Ge_{24}$ (tetragonal system), and $U_6Fe_{22}Ge_{13}$ (orthorhombic system). Within this section there are also two solid solutions $UFe_{6+x}Ge_{6-x}$ ($x<0.7$), which crystallizes in the YCo_6Ge_6 structure type and $U_2Fe_{17-x}Ge_x$ (with $2<x<3.7$), crystallizing in the Th_2Ni_{17}-type structure [7].

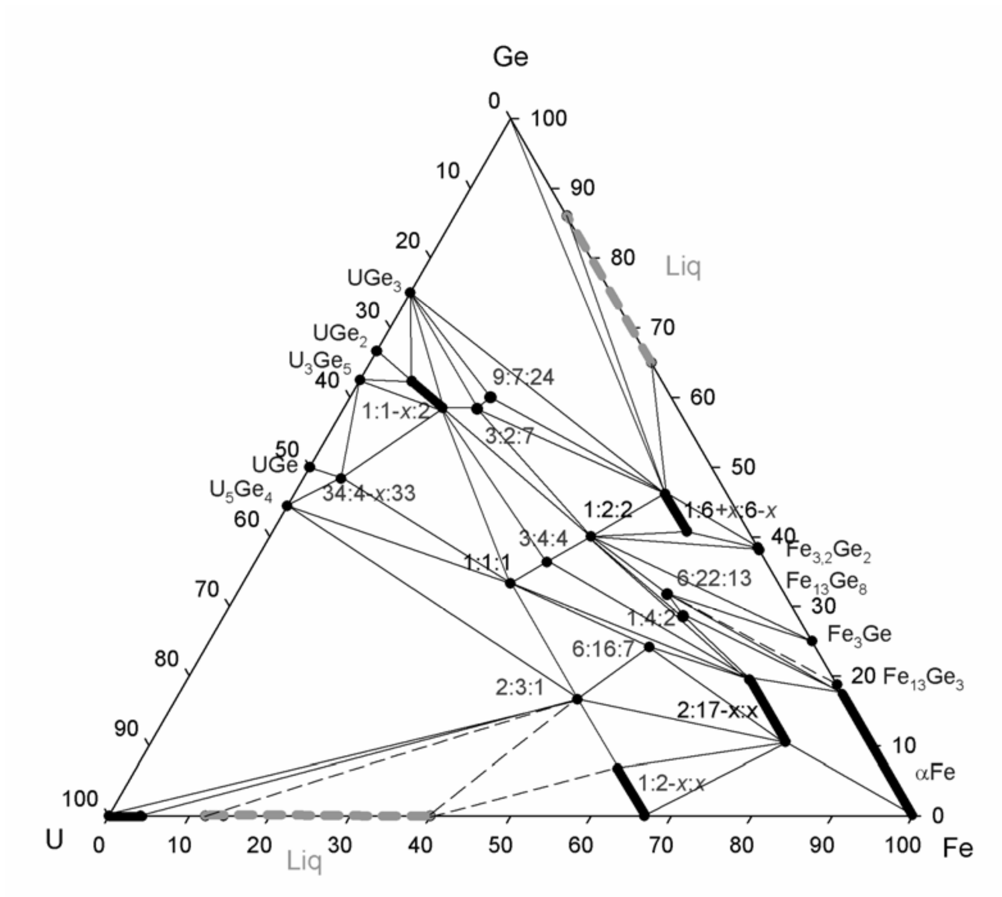

Fig. 1. Isothermal section of the ternary system U-Fe-Ge at 900ºC.

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