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## Isothermal section of the U-Fe-Ge ternary system at 900°C

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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 (P21/m, type UFeGe below 500K, and Pnma, type TiNiSi above 500K) [1], UFe<sub>2</sub>Ge<sub>2</sub> (I4/mmm, type ThCr<sub>2</sub>Si<sub>2</sub>) [2], UFe<sub>6</sub>Ge<sub>6</sub> (P6/mmm, type YbCo<sub>6</sub>Ge<sub>6</sub>) [3], and the solid solution U<sub>2</sub>Fe<sub>17-x</sub>Ge<sub>x</sub> with 2 < x < 3 (P63/mmc, type Th<sub>2</sub>Ni<sub>17</sub>) [4], in addition to the recently reported U<sub>2</sub>Fe<sub>3</sub>Ge compound (P63/mmc, type MgZn<sub>2</sub>) [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 900°C 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 900°C 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 900°C were confirmed and their crystal data are in agreement with literature. The binary compound UFe<sub>2</sub> 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<sub>2</sub>-xGe<sub>x</sub>. 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 900°C. Among these, there are nine new intermetallic compounds: U<sub>3</sub>Fe<sub>4</sub>-xGe<sub>33</sub>, UFe<sub>1</sub>-xGe<sub>2</sub>, U<sub>3</sub>Fe<sub>2</sub>Ge<sub>7</sub>, U<sub>9</sub>Fe<sub>7</sub>Ge<sub>24</sub>, U<sub>2</sub>Fe<sub>3</sub>Ge, U<sub>6</sub>Fe<sub>16</sub>Ge<sub>7</sub>, U<sub>3</sub>Fe<sub>4</sub>Ge<sub>4</sub>, UFe<sub>4</sub>Ge<sub>2</sub> and U<sub>6</sub>Fe<sub>22</sub>Ge<sub>13</sub>. Within these new phases, three are new original structural types: U<sub>3</sub>Fe<sub>4</sub>-xGe<sub>33</sub> and U<sub>9</sub>Fe<sub>7</sub>Ge<sub>24</sub> (tetragonal system), and U<sub>6</sub>Fe<sub>22</sub>Ge<sub>13</sub> (orthorhombic system). Within this section there are also two solid solutions UFe<sub>6</sub>+xGe<sub>6-x</sub> (x < 0.7), which crystallizes in the YCo<sub>6</sub>Ge<sub>6</sub> structure type and U<sub>2</sub>Fe<sub>17-x</sub>Ge<sub>x</sub> (with 2 < x < 3.7), crystallizing in the Th<sub>2</sub>Ni<sub>17</sub>-type structure [7].

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