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Characterization of new alluminides found in the ThT_2Al_{20} alloys (where T=Ti, V, Mn)

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Abstract

During the investigations on the Al-rich corner of the Th-T-Al system (where T=Ti, V, Mn), new intermetallic phases were revealed: ternary ThV_2Al_{20}, $ThTi_2Al_{20}$, $ThMn_2Al_{10}$ and pseudo-binary Th_3Al_{11} (containing traces of vanadium). Their structure was investigated by means of Transmission Electron Microscopy and powder X-ray diffraction methods. Refinement of these structures was performed applying Rietveld analysis on X-ray diffraction data. It was established that ThV_2Al_{20} and $ThTi_2Al_{20}$ phases can be ascribed to the $CeCr_2Al_{20}$ structure type, while $ThMn_2Al_{10}$ possesses the $YbFe_2Al_{10}$-type structure. The pseudo-binary $(Th_{1-x}V_x)_3Al_{11}$ phase was found to be orthorhombic (I*mmm*; a=4.4354(8) Å , b=13.8394(9) Å and c=10.3486(5)Å), isostructural to La_3Al_{11}. It was proposed that metastable Th_3Al_{11} phase can be stabilized by small amount of vanadium, which was found in its content.

Keywords: aluminides; structure solution; TEM; powder X-ray diffraction

1. Introduction

Intermetallic compounds based on f-elements may yield formation of heavy fermion ground state. For example, a large number of actinide/lanthanide-based intermetallics have been characterized as heavy-fermion systems [1, for example]. As a result of these findings, A-T-Al systems (where A=actinides and T=transition metals) were investigated thoroughly in the last decades. These researches have resulted in characterization of numerous aluminides, classified into families according to their structure types. For example: family of cubic AT_2Al_{20} phases (belonging to the $CeCr_2Al_{20}$ structure type, which can be seen as an ordered variant of the $Cr_2Mg_3Al_{18}$ type) [2-3, as an example], $A_6T_4Al_{43}$ (belonging to the $Ho_6Mo_4Al_{43}$ structure type) [4, for example] and AT_2Al_{10} (belonging to the $YbFe_2Al_{10}$ structure type) [5-7, for example]. During our investigation of the Th-T-Al system (where T=Ti, V and Mn),