Microstructure of TiAl10Si20 intermetallic alloy prepared by Spark Plasma Sintering

Knaislová, A.[1], Novák, P.[1], Průša, F.[1], Cygan, S.[2], Jaworska, L.[2] and Cabibbo, M.[3]

[1] University of Chemistry and Technology, Prague, Czech Republic, [2] The Institute of Advanced Manufacturing Technology, Krakow, Poland, [3] DIISM/Università Politecnica delle Marche, Ancona, Italy

Nowadays, several special alloy types containing Nb, Ta, Cr, W and Mo have been developed. However, due to limited resources in EU, most of these elements are now listed as a critical raw materials (CRM) [1]. Hence, the development of these alloys is not preferred. Recently, Ti-Al-Si alloys have been developed. Even though silicon is also listed as CRM, the problem can be easily solved by the use of silicon recovered from recycled electronics, because lower purity is required in these alloys than in electronics.
The Ti-Al alloys with other low-weight elements (such as silicon) are promising materials for high-temperature applications, for example for automotive and aerospace industry. They offer combination of good oxidation resistance and useful mechanical properties at temperatures higher than those possible for conventional titanium alloys [2]. Addition of silicon into Ti-Al alloys increases oxidation and creep resistance. Silicon forms in Ti-Al alloys hard and brittle Ti_5Si_3 phase, which has a significant strengthening effect. Main problem of the Ti-Al-Si alloys is their low fracture toughness, which is manageable by modifying of inner structure during the preparation [3].
Preparation of Ti-Al-Si alloys by melting metallurgy is very complicated due to high melting points of intermediary phases, high reactivity of the melt with melting crucibles and gasses in the furnace, and very poor casting properties (forming of pores and cracks). These problems can be solved by powder metallurgy. Mixture of powders is compressed and heated to a temperature lower than the melting points and intermediary phases are forming during the reactive sintering process [4]. The alloy is usually porous after reactive sintering, therefore milling and consolidation by Spark Plasma Sintering followed. Combination of mechanical alloying and Spark Plasma Sintering was also tested.
In this work, microstructure of TiAl10Si20 intermetallic alloy will be described. Microstructures after reactive sintering, mechanical alloying and Spark Plasma Sintering (various temperatures, pressures and times) will be compared.

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