Spark-Plasma Sintering of Powder Mixture of Ti and Nanoscale Ni

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TiNi intermetallic compound is well known as a representative shape-memory alloy due to its excellent properties such as shape memory effect, superelasticity, good corrosion resistance, and high damping properties. Commercially, TiNi has been processed by vacuum induction melting or vacuum arc melting techniques. However, in recent years some progress has been made in producing TiNi using powder metallurgy methods. Powder metallurgy method has advantages especially in controlling the composition and obtaining a complicated shape of end product. Many investigations on normal sintering and hot pressing of elemental Ti-Ni powder compacts have been published. The greatest problems reported have dealt with inhomogeneity in composition and low density which resulted from the formation of intermediate phases like Ti_2Ni, $TiNi_3$, etc.

In this study the spark-plasma sintering process was tried to produce a dense TiNi from the elemental Ti-Ni powder mixture. Spark-Plasma Sintering (SPS) is a similar process with a combination of conventional Electric-Current Sintering and Hot-Pressing. Electric current is applied to a specimen in pulse-form and the specimen is heated both by resistance heating of the specimen itself and the conductive die mold (usually graphite). If a self-propagating high-temperature synthesis (SHS) reaction could occur during SPS process, we can expect that the densification would be remarkably enhanced by simultaneous intensive heat input from SHS reaction and SPS. One problem is that a SHS reaction of Ti and Ni is not easily initiated at low temperature because of its relative low heat of formation compared to other intermetallics. We tried to find a possiblity for solving this problem by using nanoscale Ni powder.

Densification behavior, phase formation and developments of microstructure during SPS process were discussed.

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