Effect of Reinforcements on Tensile Property of Titanium Matrix Composites

Bong-Jae Choi, Kyung-Eui Hong, Young-Jig Kim
School of Advanced Materials Science and Engineering, Sungkyunkwan University
Si-Young Sung Materials & Processing Engineering Center, Korea Automotive Technology Institute
Myoung-Gyun Kim New Metallic Materials Research Team, Research Institute of Industrial Science and Technology

Titanium matrix composites (TMCs) have several attractive characteristics, such as elastic modulus, high temperature property, wear and oxidation resistance. However, it is adopted in limited area, such as aerospace and automobile, in past three decades because of its high manufacturing cost and extreme affinity in molten state. Generally, in the case of metal matrix composites, it is desirable to select the reinforcements which exhibit the suitable interface with the matrix, high temperature stability and similar coefficient of thermal expansion compared with the matrix. Conventional candidates of reinforcements in TMCs are SiC, Si₃N₄, Al₂O₃, TiC, TiN, TiB and TiB₂ etc. which assure the high temperature property, fatigue strength, wear and oxidation resistance. Among reinforcements as mentioned above, TiB and TiC have an outstanding compatibility with the titanium matrix, because of the similar density, analogous coefficient of thermal expansion.

Manufacturing methods of TMCs were mainly divided by powder metallurgy and casting route. In the case of powder metallurgy, processing steps were very complicated and an agglomeration of reinforcements which occur the deterioration of mechanical property. Expensive fine powder can also be an obstacle to apply industrial fields. In case of melting route, the net-shape forming is hard to obtain due to high affinity at molten state and also with the low fluidity of the melts. On the other hand, it can provide the economical and soundness of final casting. In-situ synthesis, which known as using the reaction between matrix and adding element, also assures the homogeneous distribution of reinforcement and clean interface between the matrix and reinforcement.

In this research, we adopt to the investment casting process for the economical considerations. In addition, in-situ synthesis method also developed to ensure not only homogeneous distribution but also controlled interfacial reaction between the matrix and reinforcements. Boron carbide was added to the titanium matrix using vacuum induction melting which can provide the in-situ reaction of $5\text{Ti} + \text{B}_4\text{C} \leftrightarrow 4\text{TiB} + \text{TiC}$. The in-situ synthesized (TiB+TiC) reinforced TMCs were examined using X-ray diffractometer, electron probe micro-analyzer and transmission electron microscopy. Tensile property of TMCs was examined according to the reinforcement volume fraction.