論 文 の 要 旨

題 目 Development of new manufacturing process of carbon short fiber and carbon nano fiber reinforced aluminum matrix composites and characterizations
（カーボン短繊維とカーボンナノファイバー強化アルミニウム基複合材料の新しい製造プロセスの開発と特性評価）

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With the rapid development of the automobile industries and the increasing attention to environmental issues, the demanding for lightweight, high thermal and mechanical properties materials is urgently needed. CF reinforced Al matrix composites could combine the excellent thermal and mechanical characteristics of CF and Al matrix which are expected to be applied in the automobile industry. A key challenge in fabricating short fiber reinforced composites is the fabrication process. A key challenge in fabricating short fiber reinforced composites is the develop fabrication process with cost efficient and simple operation. The traditional manufacturing of short fiber reinforced composites by liquid processes require preform manufacturing using inorganic binders (such as SiO_2 binder). However, conventional preform manufacturing techniques using inorganic binder are nontrivial procedures requiring high-energy inputs and preparation time for binder sintering process. The development of new processing techniques is attracting interest in composite materials. Therefore, a novel alternative fabrication process without preform manufacturing was developed for carbon short fiber (CSF) reinforced Al matrix composite by low-pressure infiltration method.

This thesis consists of 5 chapters. The main content of each chapter is briefly summarized as follows. Chapter 1 reviews the scientific background, the manufacturing processes and the development status of AMCs. Moreover, from the problems of the previous studies of AMCs, the idea of a new fabrication process without preform manufacturing for developing AMCs is proposed. Various predictive models for the mechanical and thermal properties of the composite are enumerated. It points out the objective of this doctoral thesis.

Chapter 2 introduces the fabrication of CSF preform and hybrid CSF-CNF preform, preforms were fabricated with SiO_2 binder. The most suitable ratio of CSF: CNF was analyzed. CSF and hybrid CSF-CNF reinforced Al matrix composites were fabricated by the low-pressure infiltration process. The microstructures of preforms and composites are investigated, as well as the effect of matrix on microstructure is analyzed. Thereafter, the effects of surface structure of CSF on interfacial reaction and the interface microstructure between CSF and matrix is investigated.

Chapter 3 describes the new fabrication process without preform manufacturing. Electroless Ni plating was conducted to CSFs for improving wettability. Before manufacturing the composites, the most appropriate electroless Ni plating condition is discussed. Ni plated CSF reinforced Al matrix composites were fabricated without preform manufacturing under different pressure. The effects of Ni plated layer of CSF, matrix type and the applied pressure on microstructures of composites are investigated. The dispersion behavior of CSFs inside the matrix was analyzed.

Chapter 4 analyzes the mechanical properties (Vickers hardness, relative density and tensile property) and thermal conductivity of CSF/Al matrix composites. The influence of matrix as well as coating material of CSFs on the mechanical and thermal properties of composites fabricated with SiO_2 binder and without preform manufacturing, respectively, are evaluated. It was noticed that the CSF/Al based composites without preform manufacturing are capable of achieving higher densification and hardness than the composites fabricated with SiO_2 binder. It proved the applicability of the new process (without preform manufacturing) developed in this research. By using the new process without preform manufacturing, different volume fraction of CSFs reinforced A336 alloy composites were fabricated, the effect of fiber content on the tensile property of composites was analyzed.

Chapter 5 summarizes the results of the above survey.