論 文 の 要 旨

題 目 Fabrication of TiB_2–Reinforced Fe Base Composites by Spark Sintering, and their Improvement in Thermal Conductivity and Hardness
(TiB_2 強化鉄系複合材料の放電焼結による作製とそれらの熱伝導率及び硬度向上)

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The conventionally commonly used hot stamping materials are SKD61. The current states of this materials are relatively low in wear resistance and thermal conductivity, which result in the low production proficiency and high maintenance cost. In addition, complex post heat treatments must be applied to SkD61 to acquire specific properties before being put into practice. However, these post heat treatments are not only costly but also environmentally unfriendly. Therefore, in order to solve the problems, the idea of fabricating a new generation of materials for the usage of hot stamping has been put forward. Based on the summary above, Fe (steel)-TiB_2 composites show great potential of possessing both high thermal conductivity and hardness. And thus, the objective of this thesis is to develop TiB_2 reinforced Fe (steel) matrix composites with both high thermal conductivity and hardness.

In chapter 1, the urgency of environmental protection was reviewed, and hence, in order to solve the corresponding problem, application of high strength steels on automobile industry for the purpose of weight reduction is proposed. However, the challenge arises regarding SKD61 steels used for producing high strength steels by hot stamping technique are introduced. Besides, the reasons for selecting spark sintering technique, Fe and TiB_2 as starting powders and the advantages of Fe-TiB_2 composites over other materials for hot stamping materials were described in detail.

In chapter 2, powder metallurgy method was selected to fabricate TiB_2 reinforced Fe base composites in this chapter. For the purpose of obtaining homogenously distributed TiB_2 Fe matrix composites, mixing parameters such as multimodal ball size distribution, rotation speed and wet and dry mixing were investigated. Morphologies of powder mixtures after mixing, $[LND\text{-}2D]_{av}$ and error bar of Vickers hardness were used to evaluate the mixing parameters. No. 6 was determined as the optimized one among the group.

The possible reactions are identified from the literature investigation. However, in order to obtain the optimum sintering parameters of Fe-TiB_2 composites, different sintering temperatures and holding times were investigated. In addition to that, the thermal conductivity, hardness of sintered compacts and reaction mechanism between Fe and TiB_2 were researched as well in chapter 3.

From the results obtained from chapter 3, Fe is not chemically stable in pure Fe which lead to the formation of Fe_2B and TiC. And therefore, new matrix of Fe-xTi (x=5, 10) alloys were designed to prevent TiB_2 from decomposing in chapter 4. The effect of Ti addition in Fe on the fabrication of Fe_2B free TiB_2 reinforced Fe base composites. Moreover, residual TiB_2, thermal conductivity, hardness and compression test of sintered compacts were carried out in chapter 4.

The results from above chapters are summarized in Chapter 5.