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論 文 要 約

THESIS OUTLINE

This thesis is entitled “Effects of solid solution, microstructure and sintering atmosphere on thermal and electrical properties of porous SiC ceramics” and consisted of 7 chapters.

Chapter 1 is the introduction of this study, which mentioned the importance of developing thermal management materials in order to achieve carbon neutral society, and porous silicon carbide (SiC) is one of the candidates with high potential to applied in these fields and also in nuclear fission and fusion reactors. The importance of meeting the demand of different applications was also indicated, which makes developing the technique to fabricate porous SiC ceramics with suitable thermal or electrical properties a crucial role. However, systematic investigation has been lacked in recent related researches. It is pointed out that discussing important factors that affecting thermal or electrical properties is the key to achieve this goal. Taking them into account, to investigate factors that controls thermal and electrical properties of porous SiC ceramics and develop its mechanism, was stated as the objective of this study.

In chapter 2 entitled “Effects of solid solution, grain size and porosity on the thermal conductivity of Al- or B-added porous SiC ceramics”, the effects of these three factors on the thermal conductivity of porous SiC ceramics with aluminum (Al) or boron (B) were discussed. The thermal conductivity of Al-added porous SiC was lower than that of B-added porous SiC, and this is found to result from the higher occupancy of Al atoms. The calculation of phonon mean-free-path also agreed with this result. Therefore, the conclusion of this chapter is that solid solution is considered to be a dominating factor other than grain size and porosity when it comes to thermal conductivity of porous SiC ceramics.

In chapter 3 entitled “Thermal and electrical properties of Al- or B-added SiC sintered with α- or β-SiC powder”, SiC ceramics of diverse porosity with Al or B addition were fabricated with two different staring powder of α- or β-SiC, and their thermal conductivity and electrical resistivity was evaluated. An alternative source of B addition, boron carbide (B_4C) was also used to investigate the effect of different chemical form on thermal and electrical properties. While Al and B form solid solution with SiC, B_4C maintained as secondary phase in SiC matrix. It promoted densification and produced lower electrical resistivity than B added ones. Besides, the electrical resistivity of Al-added SiC was lower than those with B addition, which is considered because the higher solubility of Al in SiC lattice.

In chapter 4 entitled “Thermal and electrical properties of Al- or B-added SiC ceramics sintered in nitrogen atmosphere”, the effect of sintering atmosphere on those properties of SiC ceramics fabricated using β-SiC powder was discussed. The sintering atmosphere under nitrogen atmosphere was found to

retard the grain growth and reduce the thermal conductivity comparing with those sintered under argon atmosphere. On the other hand, the electrical resistivity of Al-added SiC was found to be higher than B-added SiC, and this was discussed due to the nitridation of Al which produces aluminum nitride as a secondary phase.

Chapter 5 is entitled “Investigation of the mechanism of reduced electrical resistivity of Al- or B-added porous SiC ceramics sintered under nitrogen atmosphere”. This chapter discussed why sintering in nitrogen atmosphere produced SiC ceramics with lower electrical resistivity comparing with using argon atmosphere.

Chapter 6 is entitled “Statistical analysis of the relation of processing parameters and properties using machine learning”. The regression analysis is based on the data obtained in this study and previous researches.

In chapter 7 “Conclusion”, the important scientific findings and results in previous chapters were summarized and concluded. This study investigated how solid solution, microstructure and sintering atmosphere affect the thermal and electrical properties of porous SiC ceramics, and discussed the mechanism of reduced thermal conductivity and electrical resistivity based on the obtained results.