Thermal and mechanical properties of α-$MoSi_2$

*Afiqa Mohamad[1], Fumihiro Nakamori[1], Yuji Ohishi[1], Hiroaki Muta[1], Ken Kurosaki[1], Shinsuke Yamanaka[1,2]

[1] Osaka University, [2] University of Fukui

Abstract

Uranium silicides have higher uranium density compared with UO_2, which makes these materials attractive for accident-tolerant fuels (ATF) for light water reactors. To develop uranium silicide based ATF, it is necessary to understand the basic physical properties of various kinds of silicides, because silicides may be used as coating materials of the claddings and silicide precipitates may be formed in fuels through the reaction between fission products and uranium silicide matrix. In this study, we fabricated dense α-$MoSi_2$ polycrystalline sample and measured thermal and mechanical properties.

Keywords: Molybdenum silicide, α-$MOSi_2$, Thermal conductivity

1. Introduction

Uranium silicide is considered as one of a promising accident-tolerant fuel (ATF) used in light water reactors owing to their higher thermal conductivity and higher uranium density than UO_2. To develop uranium silicide based ATF, the basic properties of various silicides must be understood since silicides may precipitate in the fuel through a reaction between fission product and silicon in the fuel matrix, which would affect the physical properties of the fuels. Silicides may also be used as a coating material of fuel cladding if the silicides exhibit high corrosion resistance and high compatibility with the fuel cladding. In this study, we focused on α-$MoSi_2$. Although there are some reports about the thermal and mechanical properties of α-$MoSi_2$, there are discrepancies in the data reported by different groups. Therefore, in the present study, we intended to report proper information on the properties of α-$MoSi_2$ through measurements of properties, and analysis of the measured and literature data.

2. Experimental

The starting powder was pure α-$MoSi_2$ (purity 99.9%, Kojundo Chemical Lab. Co., Ltd). The powder was sintered by spark plasma sintering (SPS) at 1400 °C for 10 min under an axial pressure 100 MPa in an Ar atmosphere. The sample was subsequently annealed at 1200 °C for 24 h in evacuated and sealed quartz tube. Thermal conductivity was calculated from thermal diffusivity, specific heat capacity and density. Thermal diffusivity was measured by a laser flash technique using an LFA-457 (Netzsch) apparatus. The heat capacity of α-$MoSi_2$ was obtained from the FactSage FactPS thermodynamic database.

3. Results and discussion

The powder XRD patterns of the sample before SPS, after SPS and after annealing process were measured, which suggests that the fabricated sample was α-$MoSi_2$. The relative density of the sintered sample exceeds 96% of the theoretical density. Figure 1 shows the thermal conductivity of α-$MoSi_2$ as a function of temperature. The thermal conductivity obtained in this study was close to those reported by Vasudevan et al.[1], Bose et al.[2] and higher than that reported by Dilip et al.[3].

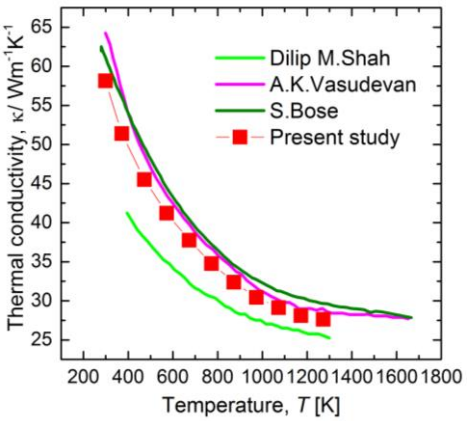

Fig. 1 Thermal conductivity of $MoSi_2$ as a function of temperature.

3. Conclusion

In conclusion, dense α-$MoSi_2$ polycrystalline sample was fabricated. The thermal conductivity of α-$MoSi_2$ was studied from room temperature to 1300 K. The thermal conductivity obtained in this study is close to the data reported by Bose et al. and Vasudevan et al. The mechanical properties such as Vicker's hardness, Young's modulus and fracture toughness will also be discussed in the presentation.

References

[1] A. K. Vasudevan, *Matrl Scienc and Eng*, A115 (1992), 1-17.

[2] S. Bose, *Journ. Matrl. Scienc*, 27 (1992), 2749-2572.

[3] D. M. Shah., et al, $MoSi_2$ and Other Silicides as High Temp Structural Materials, in *Superalloys* 1992, TMS 1992, p. 409-422.