Fabrication and Machining for U_3Si_2 Ingots Using Atomized Powder in KAERI

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1. Introduction

KAERI has been developing atomization technology which is a key technology for achieving the high-density LEU fuel. With the atomization technology presented in Fig. 1, KAERI can fabricate spherical powder; its process is much simpler than that of conventional comminuted one. The atomized powder has high purity with fewer defects, excellent irradiation performance, and high production yield rate.

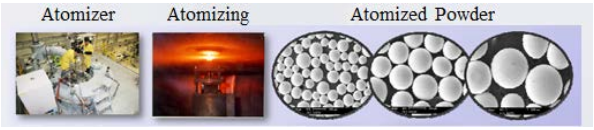

Fig. 1. KAERI Centrifugal Atomization Technology [1]

KAERI, Technische Universität München (TUM) and Forschungs-Neutronenquelle Heinz Maier-Leibnitz (FRM II) agreed Memorandum of Agreement (MOA) which covers the field of low enriched research reactor fuel studies. In accordance with it, KAERI fabricates U_3Si_2 ingots using the atomization powder and TUM/FRM II exam the feasibility of coating Al on the U_3Si_2 ingots by physical vapor deposition(PVD) for stable performance during irradiation. TUM/FRM II performs ion irradiation test and conducts post irradiation examination(PIE).

2. Methods and Results

To fabricate cylinder type U_3Si_2 ingots consisting of depleted uranium and 7.6wt.%Si, KAERI prepared 3 types of loadings: raw material(No.1), atomized powder(No.2) and crushed ingot(No.3). These loadings were put into each ceramic crucibles presented in Fig. 2. The crucibles were placed in the middle of the atomization chamber and heated in vacuum atmosphere over 1,665 ℃ which is the melting temperature of U_3Si_2.

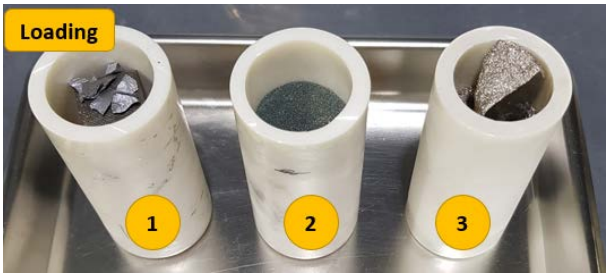

Fig. 2. Loadings: raw material(No.1), atomized powder(No.2) and crushed ingot(No.3)

After reaching a target temperature over 1,665 ℃, U_3Si_2 melting alloy in argon atmosphere was needed to be cooled down to solidify. Fabricated U_3Si_2 ingots were presented in Fig. 3. The No.1 ingot and the No.3 ingot were crushed during being separated from the crucibles.

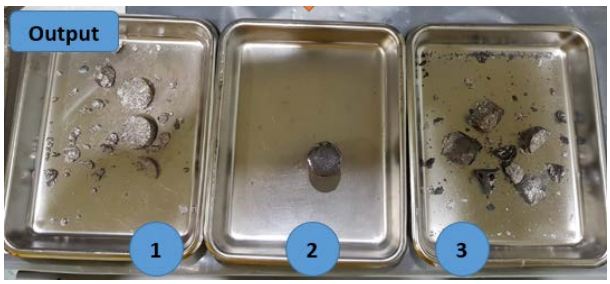

Fig. 3. Fabricated U_3Si_2 ingots: raw material(No.1), atomized powder(No.2) and crushed ingot(No.3) loadings

The surface of No.2 ingot presented in Fig. 4. had pores and the ingot was easily crushed. The fabrication result is presented in Table I. KAERI tried to machine the No.2 ingot on a lathe at 85 RPM to meet the size required by TUM but it could not be properly machined because of its porosity. Its machining result is presented in Fig.5.

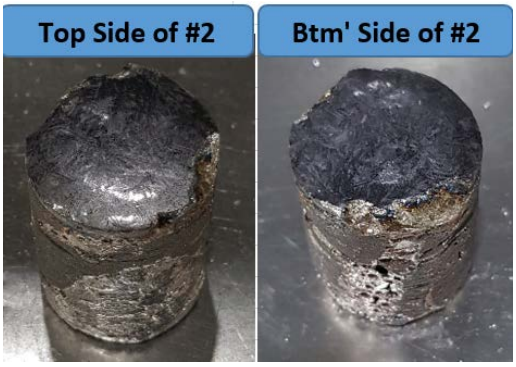

Fig. 4. The ingot of atomized powder loading(No.2)

Table I: U_3Si_2 Ingot Fabrication Result

		Ingot No.1	Ingot No.2	Ingot No.3
Load-ing	Type	Raw Material: U, Si (7.6wt%)	U-7.6Si Atomized Powder	U-7.6Si Ingot
	Net (g)	323.15	323.00	323.90

Out-put	Type	Ingot (Crushed)	Ingot	Ingot (Crushed)
	Net (g)	280.10	310.39	298.31
	Ingot Size	-	Φ30x40L	-

Fig. 5. The lathe machining result of the No.2 U_3Si_2 ingot

3. Conclusion

Based on the MOA between KAERI, TUM and FRM II, KAERI has participated in U_3Si_2 research cooperation to develop research reactor fuels. KAERI fabricated U_3Si_2 ingot using U_3Si_2 atomized powder. The U_3Si_2 ingot was too porous to be machined on the lathe. It needed further studies for improvement of U_3Si_2 ingot hardness and related machining process.

REFERENCES

[1] S.C. Park, et al., Microstructural Characterization of Atomized UAl_x Powder for High-Density LEU Dispersion Target Fabrication, Transaction of KNS spring meeting, Jeju, Korea, 2018