Development of a Centrifugal Atomization Method for the U-7Wt.%Mo of Large Particle Powders

Oh Seok-Jin, Lee Don Bae, Jang Se Jung, Oh Jong Myeong, Kim Ki Hwan,

Lee Yoon Sang,. Park Jong Man, Park Hee Dae, Kim Chang Kyu, Sohn Dong Seong

Korea Atomic Energy Research Institute

150, Deokjin-Dong, Yuseong-Gu, Daejeon, 305-353, Korea

sjoh@kaeri.re.kr

1. Introduction

The centrifugal atomization (CA) method appears to be well suited for the production of spherical shapes. Its method has the potential of providing a size control, a narrow distribution, and spherically defect free particles. A centrifugal atomization method was developed for the U-7wt%Mo powder of a large spherical particle shape. Experiments were conducted in a vacuum system with pure U and with Mo by a centrifugal atomizer. The spherical powders were obtained in the case of U-7Mo where there were various speeds of the disk. The average particle size of the U-7Mo powder was closely controlled in the size range of 105 ㎛ to 210 ㎛ by controlling the speed of the atomizing disk. Some large particles had a gamma phase. The ability of the metal droplets to spheroid in flight was dependent on the reactivity of the metal with the cooling gas atmosphere. Powder characterization included the particle size distribution, shape, and the solidification microstructure of the particles produced by the centrifugal atomization method which were characterized in this work. Powder characterization needs to be done during the rapid crystallization and the role and control of the noble and reactive gas entrainment during a processing.

2. Experimental process

The nominal composition for the powder used in this development was U-7wt% Mo. The control variables for this development were the type of a disk size used for rotating a low velocity of a disk. The disk speed was lowered in order to demonstrate the effect of the speed on the particle size of the powder. All of the atomization experiments were performed in a vacuum atmosphere. Most of the conditions such as the crucible size, pouring rate, and superheat were designed to be the same for each experiment. The molten droplets thrown from the center of the disk were convectively cooled with flowing argon gas. The argon flow rate was the primary fix used for the CA powders. To discover any effect that the rotating speed had on the shape of the particles, it was necessary to perform separate experiments to generate either spherical powders or irregular powders from the atomizing disk of the rotating speed. Approximately 2kg of powder from each of the batches was individually screened to nine particle fractions in a sieve. Portions of the selectively screened particles were examined for their structure using X-ray diffraction, microscopy on polished and unpolished cross-sections. One particle size fraction, 125~149 ㎛, was examined from each batch for morphology using microscopy and particle distribution using a particle size analyzer.

3. Results

The CA powder particles were basically spherical; however, a part of the particles had satellites and rather irregular what attached to them. The lower rotating disk speed of the SEM morphology showed predominantly spherical particles as shown in Fig.1. Fig. 2 shows the particle size distribution of the U-7Mo powder measured using a laser scattering method. It can be seen from Fig. 2 that the powder has an average particle size of 150-180 ㎛ and a narrow size distribution. The U-7Mo powder has a gamma-phase as shown in the XRD pattern in Fig. 3. Generally, the high temperature gamma-phase transforms to the low temperature phases. In this study, however, we could obtain the high temperature phase even at room temperature by a rapid solidification. The gamma-phase insures a high quality as a nuclear fuel.

In the centrifugal process, a cellular or dendrite microstructure is typically obtained. In this study, the cellular microstructure was obtained in the absence of a dendrite microstructure due the large size of the powder as shown in Fig. 4. In addition, the powder has a dense microstructure without any pores.

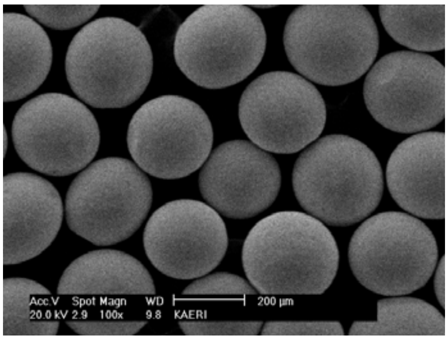

Fig.1. Scanning electron microscopy morphology U-7Mo after a sieving

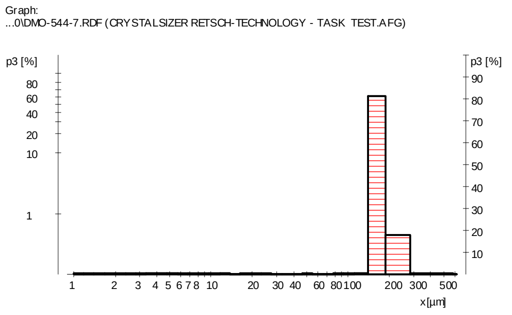

Fig.2. U-7Mo of Particle size distribution

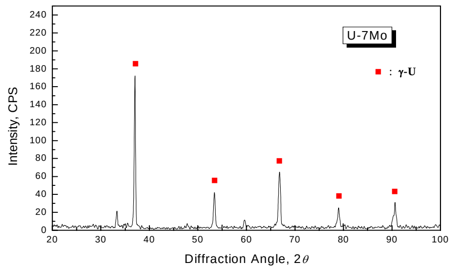

Fig.3. XRD patterns of rapidly solidified U-7Mo powders

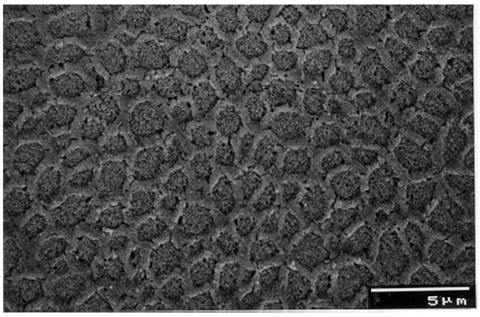

Fig.4. Microstructure of cellular for large particle

4. Conclusion

4.1 Particle size control and a narrow size distribution, which are obtained with the conventional CA method, are also obtained with the lower rotating speed disk.

4.2 A low rotating speed disk obtained the gamma-phase which insures a high quality as a nuclear fuel.

4.3 In the lower rotating speed disk of the centrifugal atomization method, a cellular or dendrite microstructure is typically obtained.

Acknowledgements

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