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PREPARATION OF PARTICLE DISPERSION ALLOYS
M-6

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Objective

A particle dispersion alloy is one type of metal-ceramic composite material, and is used as heat resistance material, wear resistance material, and electrical material. This material consists of a metal matrix and dispersed particles, and for its unique structure it has both tenacity as a metal and hardness as a ceramic. Its properties improve when the particles become finer and disperse more uniformly.

Most of the particle dispersion alloys are produced by the powder metallurgical process. This process is favorable for uniform dispersion of particles, but it consists of complicated techniques such as mechanical alloying and hot extrusion, and has the following drawbacks:

1. It is difficult to fabricate large-sized products.

2. The amount of particles is limited to a few percent.

3. The process is complicated and expensive.

To overcome these drawbacks, recently special attention has been paid to conventional melting process. However, under terrestrial conditions, dispersions separate immediately due to the different specific gravities of the metal matrix and the particles and thermal convection effects. The microgravity environment is, therefore, considered to be an attractive place for fabricating the dispersion alloy.

This space experiment is carried out to clarify the influence of microgravity on the properties of the particle dispersion alloy and to obtain a deeper understanding of the experiment under the microgravity environment.

Outline of Experiment

The outline of the experiment is as follows:

1. Sample

Samples used in this experiment are TiC-particle dispersion alloys. Their composition is given in Table 1. Molybdenum is an element used to improve the wettability of nickel and TiC. Chromium is added for improving oxidation and corrosion resistance, as well as for hardening the matrix. Cobalt is added for hardening the matrix.

These samples are prepared using powders of their constituents by the following procedure:

Weighing of powder→Mixing→Consolidation of mixed powder in high temperature.

2. Sample Crucible

Figure 1 shows the cross-section of the sample crucible. It is made from graphite and is designed to process three samples simultaneously. To prevent leakage of the melt, a special glass developed in our laboratory is placed at both ends of the crucible as shown in Figure 1.

3. Sample Cartridge

The cross-section of the sample cartridge is shown in Figure 2. The cartridge is made from tantalum and consists of a sample crucible holder and a pressurizing mechanism. The pressurizing mechanism is for squeezing the gas released from molten alloys, from the inside of the sample to the outside, so that it is very useful for fabricating solid samples free from voids.

After the cartridge is installed in the Large Isothermal Furnace, all of the operations such as heating, isothermal holding, pressurizing, etc. are carried out automatically by the aide of a computer.

Related Experiment

Related experiments were conducted by TT-500A Sounding Rocket (NASDA) in 1980, 1981, and 1982. These experiments have proved that a low-gravity environment is favorable for uniform dispersion of particles. Figure 3 illustrates the microstructures of the samples processed in space and on the ground. It is evident that the sample obtained in space has a structure more homogeneous than the sample obtained on the ground.

Sample	Ni	TiC	Mo	Cr	Co
No. 1	Bal	20	10	10	-
No. 2	Bal	20	10	-	10
No. 3	Bal	20	9	9	9

Table 1. Composition of samples used in this experiment (mass %)

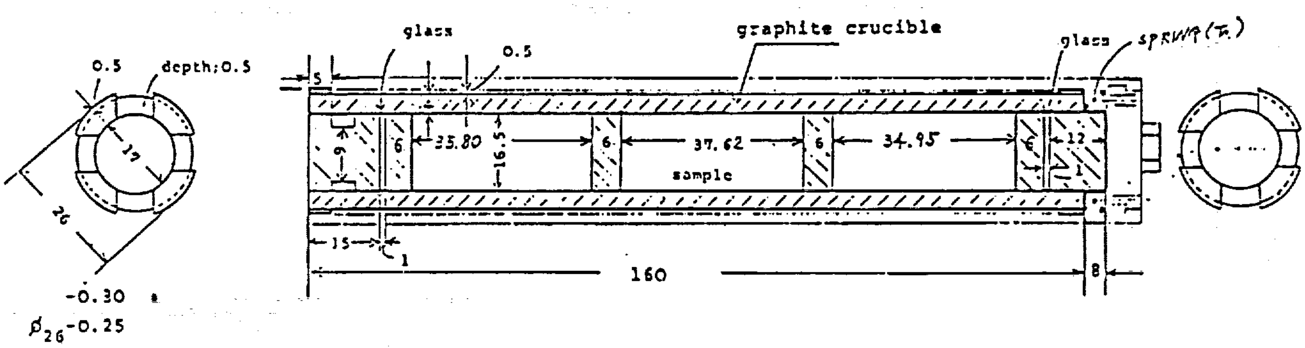


Figure 1. Cross-section of sample crucible.

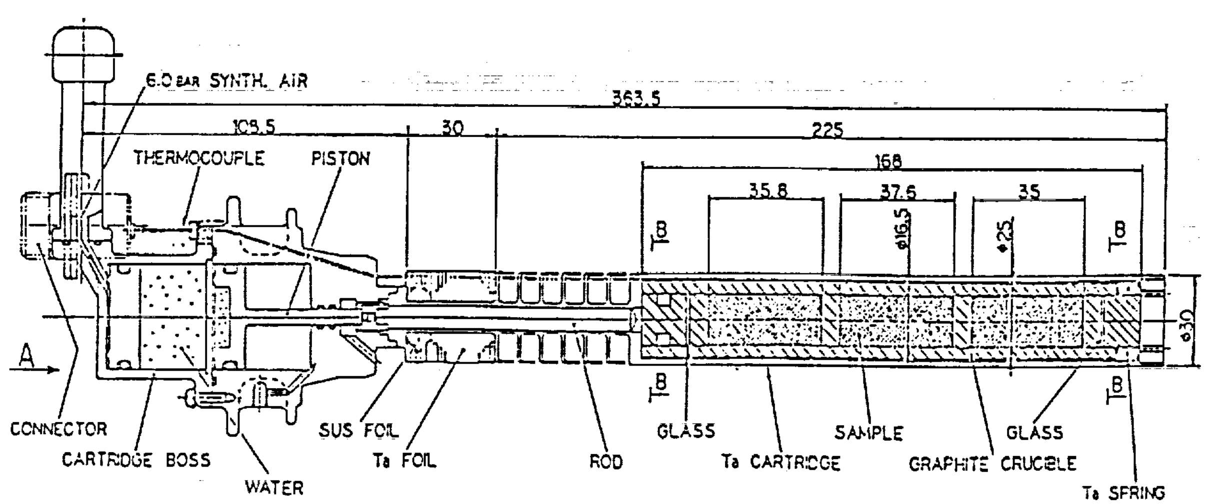
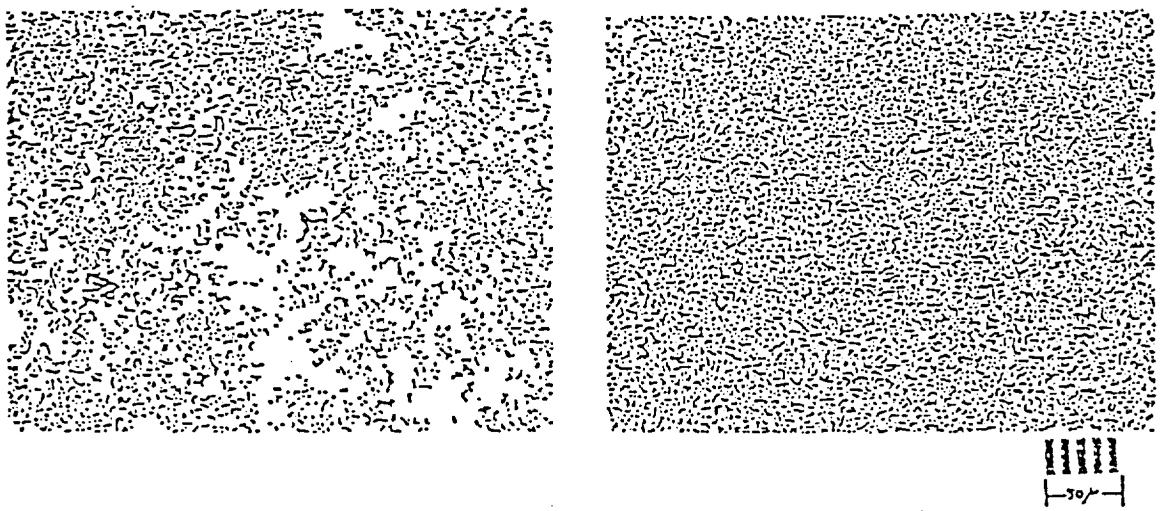


Figure 2. Cross-section of sample cartridge.



Processed on the ground | Processed in space

Figure 3. Microstructures of TiC-particle dispersion alloy.