Alloying process for Cu-Zn mixed powder using the tribo-mechanical approach

H. Miki[1*], T.Sakuma[2], N. Nakayama[3], T. Miyazaki[4], H. Takeishi[2]

[1)]Frontier research Institute for Interdisciplinary Science, Tohoku University, Aramaki aza Aoba 6-3, Aoba-ku, Sendai 980-8578, Japan.
[2)]Science and Mechanical Department, Chiba Institute of Technology, 2-17-1 Tsudanuma, Narashino 275-0016, Japan.
[3)]Mechanical Systems Engineering Department, Shinshu University, Wakasato 4-17-1, Nagano, 380-8553, Japan.
[4)] Technical Division, School of Engineering, Tohoku University, 6-6-11 Aramaki-aza-aoba, Aoba-ku, Sendai 980-8579, Japan.

[*]Corresponding author for miki@wert.ifs.tohoku.ac.jp

1. Introduction

A new method of solidifying metal powder by tribo-mechanical process under compression stress was developed[1]. In the solidified specimen, recrystallization is suppressed, so that nanoscale crystal grains remain. The hardness of the specimen prepared by this process is increased relative to materials prepared by other methods. The correlation between the crystal structure and crystallization of an aluminum plate with crystal grains 100−200 nm in diameter prepared by this molding process are reported [2].This method is termed the compression shearing method at room temperature.The metal powders are solidified by enforced plastic flow with tribo-mechanical process, and external heating isnot required.

Recently, a new high-speed, room-temperature alloying process was developed [3], which is termed the compression rotation shearing method at room temperature.

In this study, the alloying process of Cu-Zn mixed powder using compression rotation shearing method was investigated.

2. Experiment

In the compression rotation shearing method, metal powders are solidified by enforcing plastic flow by simultaneously applying compressive loading and a shear force. A schematic diagram of this process is shown in Fig. 1. The mold is composed of a tool, a container and an under-punch and all parts are made of dies steel.

Container is filled with Cu-Zn powder at the beginning and the tool is inserted. Compressive load is then applied and a shear force is introduced by rotation of the tool. The powder is consequently solidified in the process. The applied compressive load is measured by a strain gauge fixed to the under-punch. The compressionstress and the pivot rotational speed were set respectively to 57.3 MPa and 460 rpm, and the rotation time was set to 60 sec. Solidification process was carried out at room temperature in the atmosphere.

3. Results

X-ray diffraction showed the CuZn alloy structure, while EDX SEM observation revealed that Cu and Zn disperse uniformly. Details of the crystal grain size are shown in Fig. 2. The Cu-Zn composite does not recrystallize which has fine crystal grains. We conclude Cu-Zn mixed powder was clearly solidified and alloyed under tribo-mechanical process.

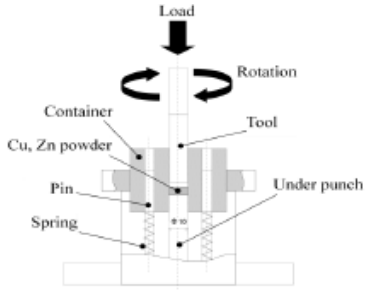

Fig. 1 Schematic diagram of compression rotation shearing method.

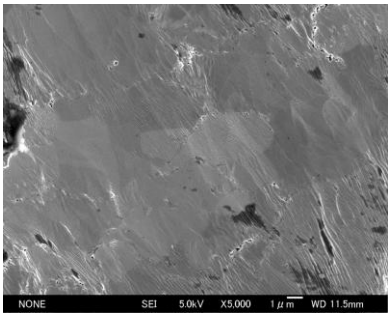

Fig. 2 SEM micrograph of the Cu-Zn composite.

4. References

[1] H. Takeishi, N. Nakayama, H. Miki, “Consolidation with Grain Refinement by Compression Shearing Method under Room Temperature,”J. Soc. Mat. Sci., Japan, 54(3), 2005, 233-238.

[2] H. Miki, N. Nakayama, H. Takeishi, “Dynamic Molding of Powder Particles at RoomTemperature,” Mat. Sci. Forum, 706-709, 2012, 1955-1960.

[3] N. Nakayama, S. Kato, H. Takeishi, H. Miki, “Consolidation of Ti powder by a compression rotation shearing system at room temperature,” Adv. Mat. Res., 409, 2012, 3-8.