Improvement of Porous-Structure Controllability for Fabrication of Sintered Porous Aluminum Materials by Coating Al Powder with Tin

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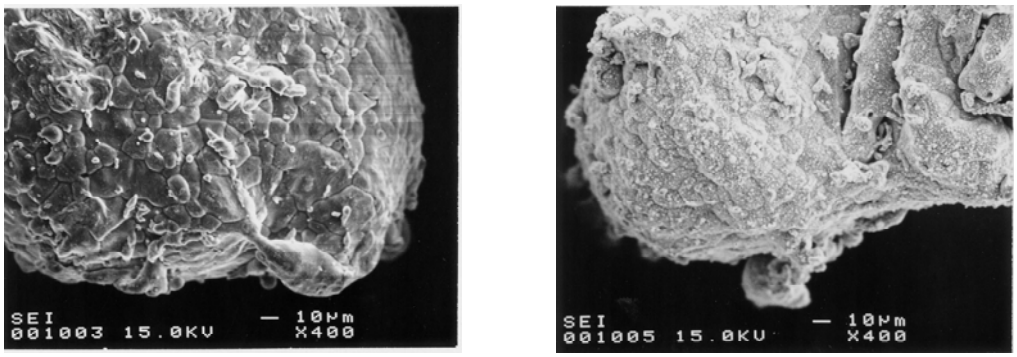
The deposition of pure tin onto pure aluminum powder in its self-convective motion by magnetron DC sputtering was examined in order to prepare Al-Sn composite powder and thereby to improve the sintering of the aluminum particles, aiming at the development of highly structure-controlled porous aluminum materials by space-holder method in powder metallurgy processing. The effects of the sputter-deposition of tin on porous structure and mechanical properties of the sintered compact were investigated.

Figure 1 shows typical SEM images of the surface of the aluminum particles before the sputter-deposition and those obtained after the sputter-deposition. The surface of the obtained particles appeared to be covered with deposited tin fine particles without any peelings of the deposits of tin observed. Thus it seemed that the sputtered tin could be adherently deposited onto the surface of the aluminum particles.



(a) Before the sputter-deposition (b) After the sputter-deposition

Fig. 1. SEM image of the surface of the aluminum particles before the sputter-deposition(a) and that obtained after the sputter-deposition(b).

Figure 2 shows the result of EPMA analysis on the surface of the particles obtained after the sputter-deposition in this study. According to EPMA analysis, Kα X-ray peaks of Sn were definitely detected on the surface of the particles. Thus it was confirmed that the obtained particles were coated with the tin deposits. According to DSC analysis, it was found that the obtained particles were coated with pure tin deposits because endothermic peak was detected at the temperature of the melting point of pure Sn, which was lower than around 250℃. Furthermore, according to its quantitative analysis of the tin film, the average thickness of the tin film could be estimated to be around 1 nm from its endothermic calorie.

Next the preparation of porous aluminum materials was carried out using the Al-Sn composite powder obtained above by space-holder method in ordinary powder metallurgy processing. It was found that the mechanical durability of the pre-sintered compacts obtained after heating up to the removing temperature (400℃) for the sublimation of resinous spacer materials was improved by the sputter-deposition. It was also found that the sintering of the aluminum particles was highly enhanced at the temperature of 650℃ by the sputter-deposition and thereby that mechanical properties of the sintered compacts was considerably improved.

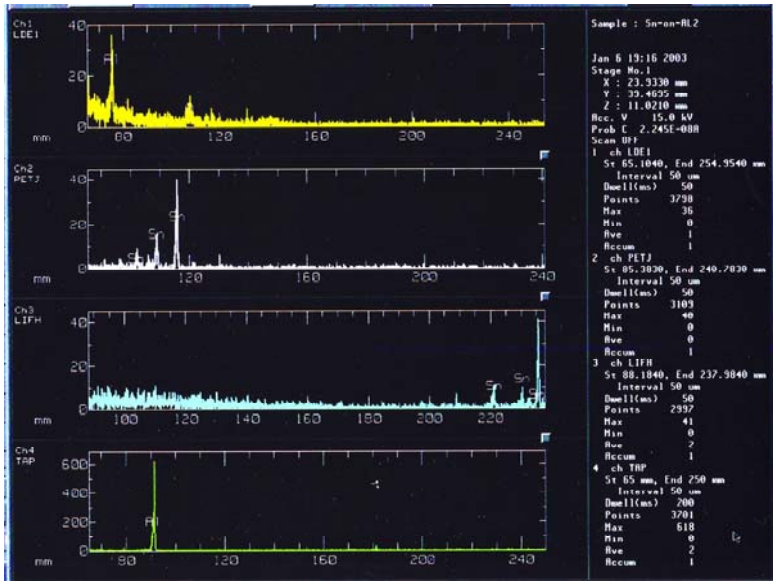
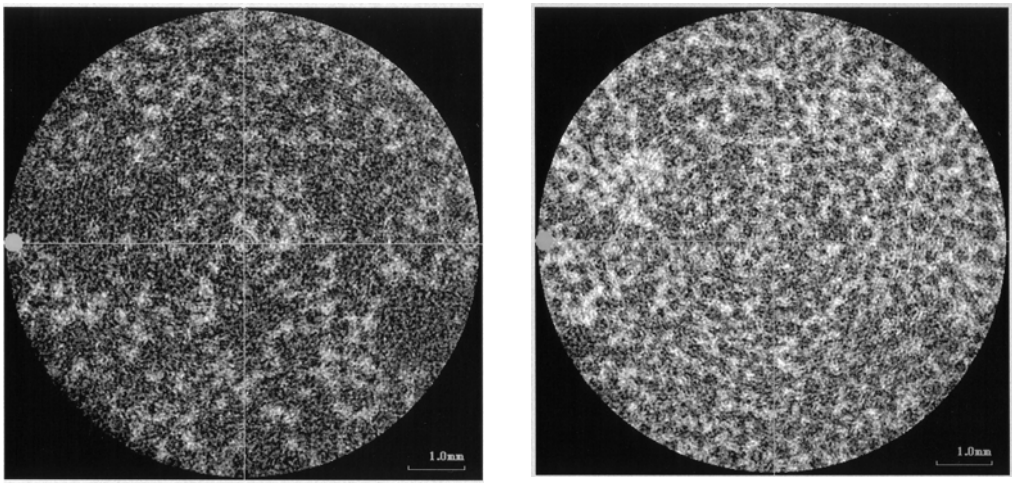


Fig. 2. Result of EPMA analysis on the surface of the particles obtained after the sputter-deposition in this study.

Figure 3 shows the X-ray C.T. images for porous structures of the sintered porous compacts with the porosity 80% obtained from aluminum powder without the tin sputter-deposition and with the tin sputter-deposition. According the C.T. images, it was found that the porous structure of the sintered porous materials with the porosity 80% was better regulated by the sputter-deposition, compared to that without the deposition. Furthermore, regarding to their compressive properties, it was found that the plateau stress of the sintered porous materials reached by the sputter-deposition twice as high as than that without the deposition.



(a) Without sputter-deposition of Sn (b) With Sn sputter-deposition of Sn

Fig. 3. X-ray C.T. images for porous structures of the sintered porous compacts with the porosity 80% obtained from aluminum powder without the tin sputter-deposition(a), and with the tin sputter-deposition(b).

Therefore it was concluded that the coating of aluminum powder with nano-order thick tin deposits enables the porous-structure to be controlled more effectively in fabricating sintered highly porous aluminum materials, as well as improves their mechanical property.