CHARACTERISTICS ON THE INTERMETALLIC COMPOUND OF METAL MATRIX COMPOSITE (Ni/AC8A) USING NICKEL POROUS PREFORM

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Introduction

Al alloy composite material that Ni is added by reinforcement is used for piston of diesel engine, because high temperature properties, strength, corrosion resistant are improved excellently than existent Al alloy [1-2]. And, in case of processing, interface between Ni and Al improves wear resistant by intermetallic compound of high hardness.
Existent process methods of MMC using preform were manufactured by high-pressure. But, it cause deformation of preform or fault of completed MMC. Using low-pressure as infiltration pressure can prevent this problem, and there is an advantage that is able to reduce the cost of production by small scale of production equipment.
Accordingly, in this study produced Al composite material that Ni is added by low-pressure infiltration, and also observed microstructures to analyze the characteristics of intermetallic compounds that are generated by the reaction of the reinforcement and the matrix metal.

Experimental Method

Low pressure infiltration process
The matrix material used in the present study is AC8A(KS D 2330), which is supplied by Dooin Co., Ltd. of South Korea. Table 1 shows the chemical composition of the AC8A product used as the matrix metal in the study, As for the reinforcement, we used a Nickel porous preform with 5% volume fraction (V_f), which is supplied by Sumitomo Electric Toyama o., Ltd. of Japan in Fig. 1.

Table 1. Chemical composition of the AC8A (wt %)

Materials	Cu	Si	Mg	Fe	Mn	Ni	Ti	Cr
AC8A	0.99	12.2	1.05	0.38	0.12	1.02	0.06	0.04

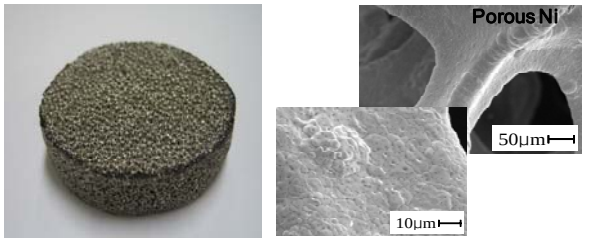


Fig. 1 Nickel porous preform for processing Metal Matrix Composite.

This study employed hydraulic cylinders and load cells for detecting the load, and the load used to induce penetration of the reinforcement by the matrix metal was limited to a maximum of 0.3 MPa. Meanwhile during the manufacture by infiltration, we differentiated the temperature conditions during the composite infiltration to 650, 700 and 750℃ respectively.

Observation of microstructure
The micro-structure was observed using the optical microscope (Olympus BX60M). Because the molten structure is composed of the matrix metal, precipitated, this is difficult to examine, therefore the revealed structures were also studied through element analysis and quantitative analysis using the EPMA, the XRD, and the SEM/EDX.

Results and Discussions

The elements revealed through XRD analysis in the structure analysis of the composites manufactured at each respective infiltration temperature like the Fig.2 shown. The Al element indicates the matrix metal, and the Si element is the element that is most abundantly contained in the matrix metal AC8A and is judged to be a precipitated element generated by melting. In particular, the Al_3Ni element is an intermetallic compound that is created by molten reaction or during the manufacture of composites by casting, and it is generated when a small quantity of A1 reacts with the Ni element at a relatively low temperature.

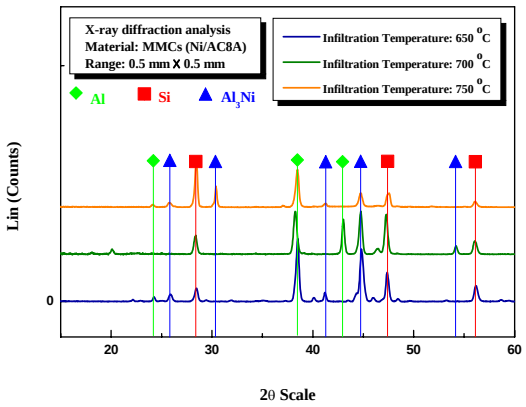
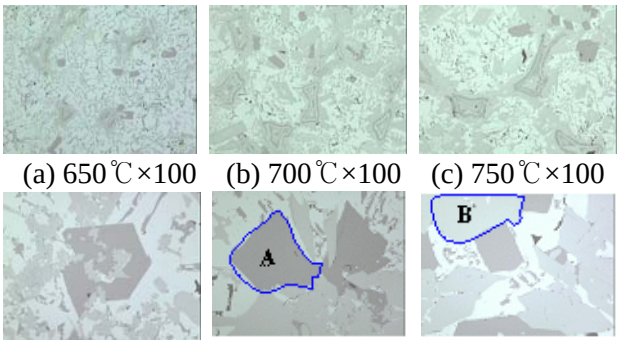


Fig. 2 Analysis of Ni/AC8A composites by XRD (X-ray diffraction).

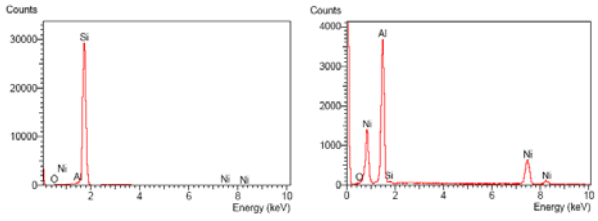
Fig. 3 shows the microstructure of MMC manufactured at the respective temperatures, reviewing the features of the composite structures observed in the optical microscope at 100 times magnification, it is noted that at (a) 650oC the size of the unique structures are smaller than at other temperatures and that micro-structures are distributed consistently. At (b) 700oC and (c) 750oC, bright colored structures are more widely distributed compared to (a). So using SEM/EDX to examine each unique structure and to study the transformation of the intermetallic compounds or precipitated element, Fig. 4 shows EDX analysis that was conducted on the observed unique structure, quantitative analysis led us to deduce that the red-colored [A] structure revealed in the optical microscope is composed solely of the Si element, quantitative analysis [B] structure of the bright-colored grain led us deduce that it is a composed of the A1 element and the Ni element and that it is an intermetallic compound generated during the manufacture of the composite.



(a) 650℃×100 (b) 700℃×100 (c) 750℃×100

(d) 650℃×500 (e) 700℃×500 (f) 750℃×500

Fig. 3 Microstructure of MMC (Ni/AC8A) by optical microscope (Olympus BX60M).



(a) EDS analysis: A (b) EDS analysis: B

Fig. 4 Analysis of Ni/AC8A composites by SEM/EDX

Si element was precipitated in the matrix metal during melting. This structure was uniformly distributed regardless of the infiltration temperature, and the grain size was also relatively uniform. In general, the Al_3Ni element has excellent hardness and strength but is very brittle [3]. Therefore, when the grain size of Al_3Ni increases, its brittle property may cause an inversely negative effect on the composite. This issue of strength, which is dependent on grain size in conjunction with the characteristic of the intermetallic compound, is another matter that should be taken into consideration when manufacturing composites [4].

Conclusions

In this study, we manufactured the Ni/AC8A metal matrix compound using the low-pressure infiltration method, and studied the characteristics of the microstructures that were generated in the process, leading to the following conclusions:

(1)The structures of compounds created at 650C were distributed minutely, the crystallization size of the precipitated substances or the compounds tended to increase as the infiltration temperature increased.

(2)The molten reaction precipitated the Si sub-stance as well as the inter-metallic compound Al3Ni, and while these structures have high hardness value, they also have brittle properties.

Acknowledgment

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