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Research Article

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Comparıson of Al-Metal Matrıx Composıtes Produced by *In Sıtu* Hot Press Method

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Abstract In this work, production and mechanical properties of *in situ* aluminum matrix composites were investigated using binary Al-TiO_2 and triple Al-TiO_2-C powder systems. Microstructural characterization was carried out by optical light microscope. Mechanical properties were determined by hardness measurement experiments. When Al_3Ti intermetallic compound and Al_2O_3 ceramic phases are formed in the binary Al-TiO_2 composite, the triple Al-TiO_2-C composite consists Al_2O_3 and TiC phases. Applied sintering parameters and addition of 'C' caused brittle Al_3Ti phase to turn into TiC phase. The triple Al-TiO_2-C composite exhibited higher hardness than the binary Al-TiO_2 composite.

Keywords *In situ*, composite, hardness

1. Introduction

Al matrix composites have a widespread use in chemistry, automobile and aviation industry due to high strength/weight ratio [1]. Impurity and interface reactions which as a result ofthermodynamic instability of reinforcing elementat interface of aluminummatrix composites produced by powder metallurgy and casting method affects negatively mechanical properties composite homogeneity [2]. Thanks to *in situ* method which is an alternative to these production methods, ceramic particles-intermetallic compounds (reinforcements) are formed *in situ* as a result of the reactions occurring in liquid aluminum alloy and successful mechanical, wear and corrosion results have been achieved. As the reinforcements are generated directly from chemical reaction within the matrix, the composites are of many excellent advantages, such as clean reinforcement-matrix interface, fine and thermodynamically stable reinforcements, good compatibility and high bond strength between reinforcements and the matrix, and low fabrication costs [3].

Particle reinforced metal matrix composites (aluminum,magnesium, titanium etc.) are used in automotive, transportation and weight sensitive aviation sectors. Al_2O_3 reinforced metal matrix composites are used in nozzles, cylinder liners and rotors whereas TiC reinforced ones are used in armor materials and cutters(in processing of steel and cast iron at high cutting speeds)[4].

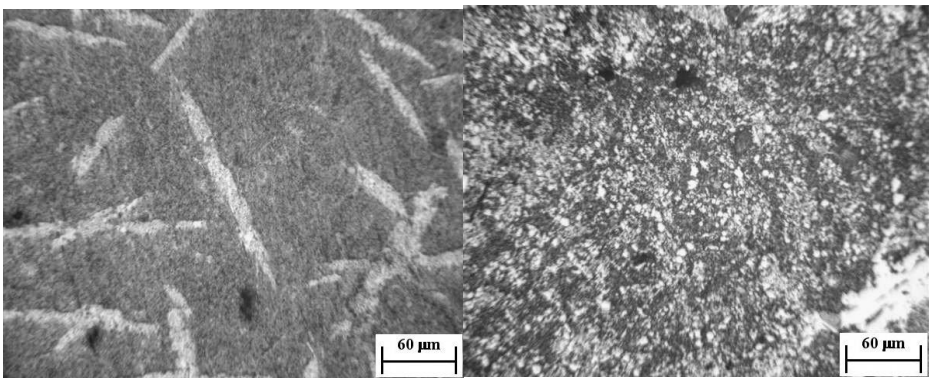
In this study; investigatingof mechanical properties and production by hot press method of *in situ* aluminum matrix composites are aimedusing binary Al-TiO_2 and triple Al-TiO_2-C powder systems.

2. Material and Method

As raw material,Al (99% purity, 1-5 µm), TiO_2 (94% purity, 0.3-1 µm), C (99% purity, 1-2 µm) powders have been used.Powders in both systems were mixed in pure alcohol during 1 hour. The powder mixtures were pressed at 70 bar pressure after being dried at 70°C for 1 hour. After for 1 hour holding time at 1000 °Cin argon gas atmosphere (to occurin situ reactions), to minimize porosity, samples were hot pressed under 10 bar pressure at semi-solid/liquid temperature of aluminumafter removed from furnaceand then were left to cool in air environment as balanced Analysis of microstructure and hardness measurements were made of in situ composites. Polished samples with standard methods have been investigated under an optical microscope. The hardness measurements were made in Brinell hardness tester preferred for light metal alloys with 306 N load ($HB_{2,5/31,25}$).

3. Results and Discussion

Microstructures of *in situ* composites produced by hot pressing are given in Figure 1. In binary Al-TiO_2 composite, gray bar appearance plates aredistributed homogeneously in the microstructure. In Al-matrix of the triple Al-TiO_2-C composite, ceramic particles formed *in situ* are uniformly distributed in a light color appearance. The light colored particles in literature are defined as Al_2O_3 and TiC, while the gray colored plate is called Al_3Ti [1].



(a) **(b)**

Figure 1: (a) Binary Al-TiO_2 composite (b) Triple Al-TiO_2-C composite

Within scope of this study, hardnesses of the composites produced by hot press method is given in Table 1. Due to formation of TiC compound in the triple Al-TiO_2-C composites, the hardness increased by 2 times according to the binary Al-TiO_2 composite.

Table 1. Hardnessvalues of tested composites

Sample	***Hardness ($HB_{2,5/31,25}$)***
Binary Al-TiO_2	61
Triple Al-TiO_2-C	122

Al_3Ti intermetallic compound is a brittle phase [5]. Itmust be eliminated in microstructure. If so, it can be observed an increase in ductility of composites [6].

4. Conclusions

In this study, microstructures of aluminum matrix composites produced byin situ hot press method and results obtained from hardness testsare summarized briefly:

- The microstructure of the binary Al-TiO_2 and triple Al-TiO_2-C composites have Al_2O_3-$Al_3Ti$and Al_2O_3-TiC particles, respectively.
- Triple Al-TiO_2-C composite has higher hardness due to hard Al_2O_3-TiC particles.
- Elimination of Al_3Ti will cause improvement of mechanical properties of composites.

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