MICROWAVE SINTERING AND CHARACTERIZATION OF CU-CR-SIC COMPOSITE MATERIALS

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Abstract

Cupper matrix composites containing 1,2,3,4%SiC has been fabricated by microwave furnace sintering at 1100°C temperature. Compounds formation between Cu –Cr and SiC powders is observed after sintering under Ar shroud. XRD, SEM(Scanning Electron Microscope), mechanical testing and measurements were employed to characterize the properties of Cu + Cr + SiC composite. Experimental results suggest that the best properties as hardness 183,57 HV were obtained for Cu + Cr + 4%SiC composite.

Keywords: Powder metallurgy, Microwave Sintering, Ceramic-Metal Composites

1. INTRODUCTION

Pure copper is extremely difficult to cast because of proneness to surface cracking, porosity and formation of internal cavities during casting. The casting characteristics of copper can be improved by the addition of small amounts of elements like beryllium, silicon, nickel, tin, zinc, chromium and silver. Cast copper alloys are used for applications such as resistance welding electrodes, bearings, bushings, gears, fittings, valve bodies, and iscellaneous components for the chemical processing industry. Copper matrix composites are promising materials which are well suited for applications in electrical sliding ontacts such as in homopolar machine and railway overhead current collectionsystem [1–4].

In the present work, Composites work Cu-Cr-%1SiC, Cu-Cr-%2SiC, Cu-Cr-%3SiC and Cu-Cr-%4SiC, were fabricated at microwave furnace, microstructure were characterized and mechanical properties such as hardness and density were studied. It was observed that

2. MATERIAL-METHOD AND PREPARATION OF SAMPLE

Starting powders employed in this study were as follows: the purity of 99.8% for Cu-Cr powders with a particle size lower than 70 μm, the purity of 99.95% for SiC ceramic powders a particle size lower than 75 μm The composition of Cu-Cr-%1SiC, Cu-Cr-%2SiC, Cu-Cr-%3SiC, and Cu-Cr-%4SiC, powders specimens were prepared in 10g square prisma compressed pre-form. They were mixed homogenously for 24 hours in a mixer following the weighing. The mixture was shaped by single axis cold hydraulic pressing using high strength steel die. A pressure of 200 Bar was used for the compacting all the powder mixtures. The cold pressed samples underwent for a sintering at 1100°C for 1 hours in a microwave furnace using Argon gas atmosphere. The specimens were cooled in the furnace after sintering and their micro hardness and shear strengths measurements were carried out using METTEST-HT (Vickers) micro hardness tester machine, respectively.

LEO 1430 VP model Scanning Electron Microscope fitted with Oxford EDX analyzer was used for microstructural and EDX compositional analysis.

The volumetric changes of Cu-Cr-%1SiC, Cu-Cr-%2SiC, Cu-Cr-%3SiC and Cu-Cr-%4SiC, composites material after sintering were calculated by using (d=m/V) formula (Fig. 1). The volume of post-sintered samples was measured with Archimedes principle. All the percentages and ratios are given in weight percent unless stated otherwise.

3. EXPERIMENTAL RESULTS AND DISCUSSION

3.1. Characterization of specimens

In the study, the samples prepared and shape were sintered at 1100ºC in microwave furnace and made ready for physical, mechanical and metallographic analyses. Density-temperature change curve is shown in Figure 1. The highest sintered density was achieved at 1100°C as 6,016g/cm^3.

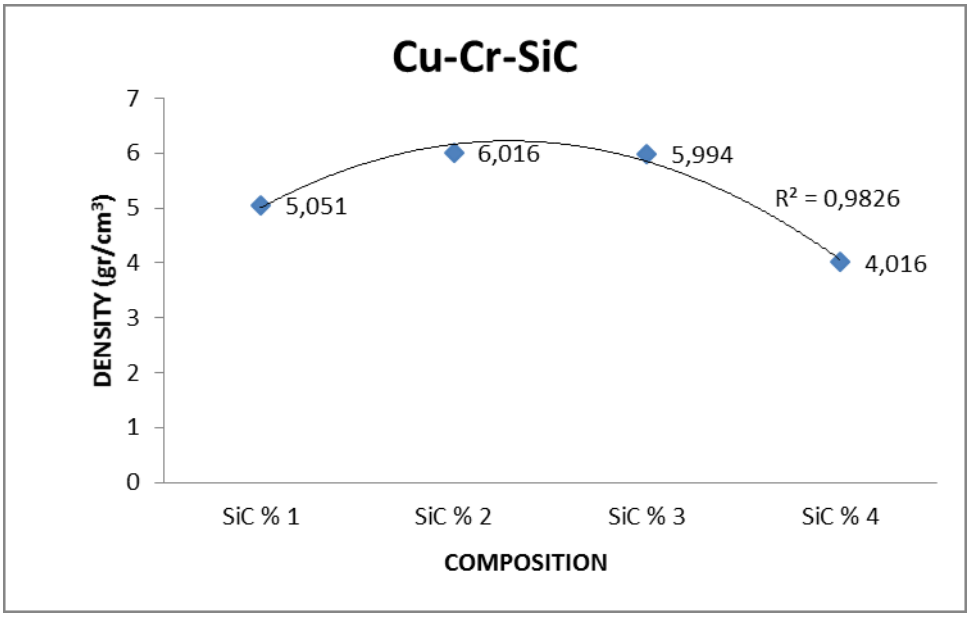

Fig.1 The density change with respect to sintering temperature

The micro hardness-temperature change diagram is shown in fig 2. The micro hardness values of the composite samples produced using microwave sintering technique within the temperature at 1100ºC. According to this, the highest micro hardness value in the composite samples produced using powder metallurgy method was observed to be 183.57HV at Cu-Cr-%4SiC composites.

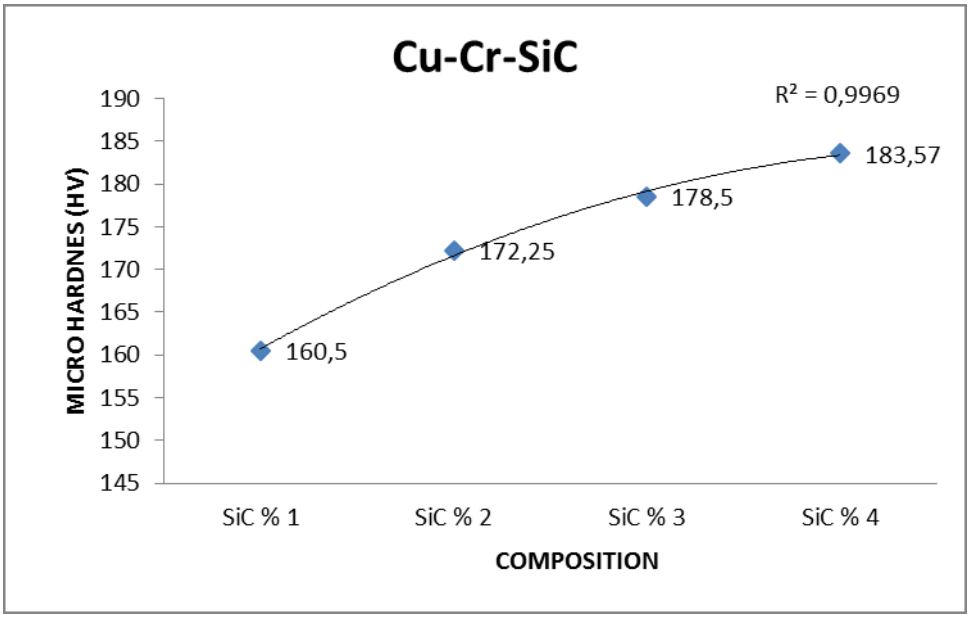

Fig. 2 The micro hardness tests results from sintered specimens treated at different compositions

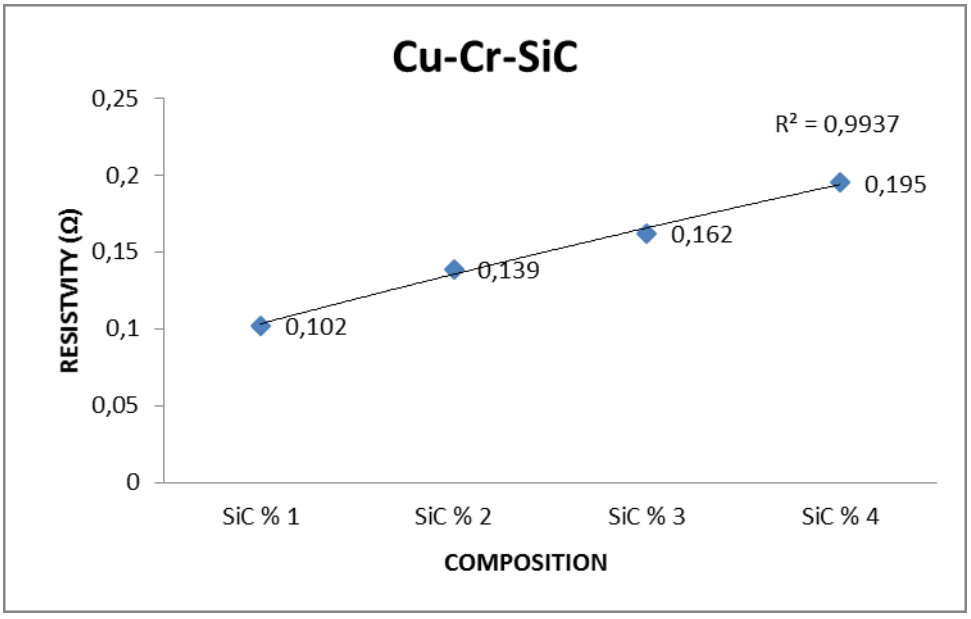

Fig. 3 The resistivity tests results from sintered specimens treated at different compositions

3.2 Metallographic Analysis

The SEM analysis result of the metal matrix composite specimen obtained from Cu-Cr-%1SiC powders sintered at 1100 ºC is shown in Figure 4. grain growth is observed and a homogeneous structure and grain boundaries can be seen that the pores very smaller. This density, and hardness values are confirmed.

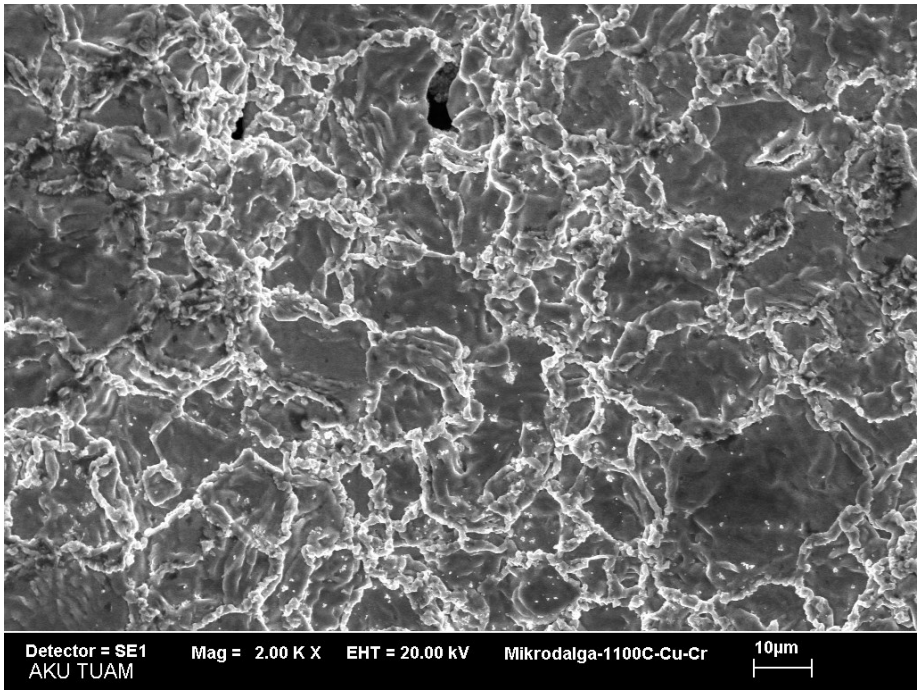

Fig. 4 SEM view of Cu-Cr-%1SiC composite 1100°C

The SEM analysis result of the metal matrix composite specimen obtained from Cu-Cr-%4SiC powders sintered at 1100 ºC is shown in Figure 5. grain growth is observed. It is not a homogeneous structure and grain boundaries can be seen that the pores very smaller. This density, and hardness values are confirmed.

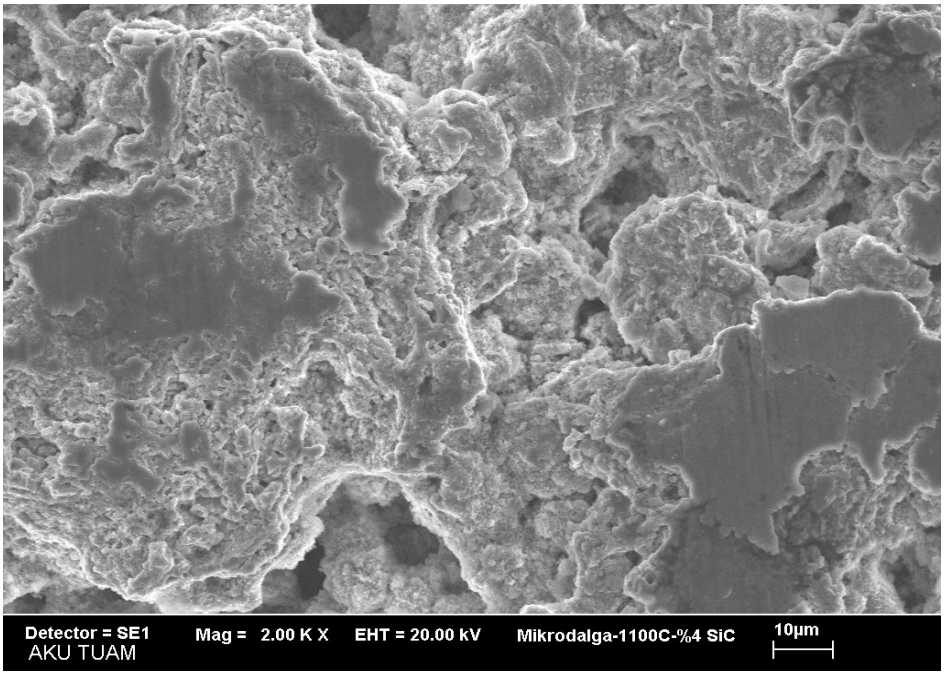

Fig. 5 SEM view of Cu-Cr-%4SiC composite 1100°C

3.2 X-Ray Diffraction Analysis

Fig. 6 present the XRD analysis results of Cu-Cr composites at 1100°C. The Cu phase, which was the main addition in the composite, has evidently the highest peak intensity over the other phases present in the XRD analysis in the Cu-Cr composites. Fig. 6which shows the presence of Cu, Cr and $CuCrO_2$ phases in the fabricated ceramic-metal composites.

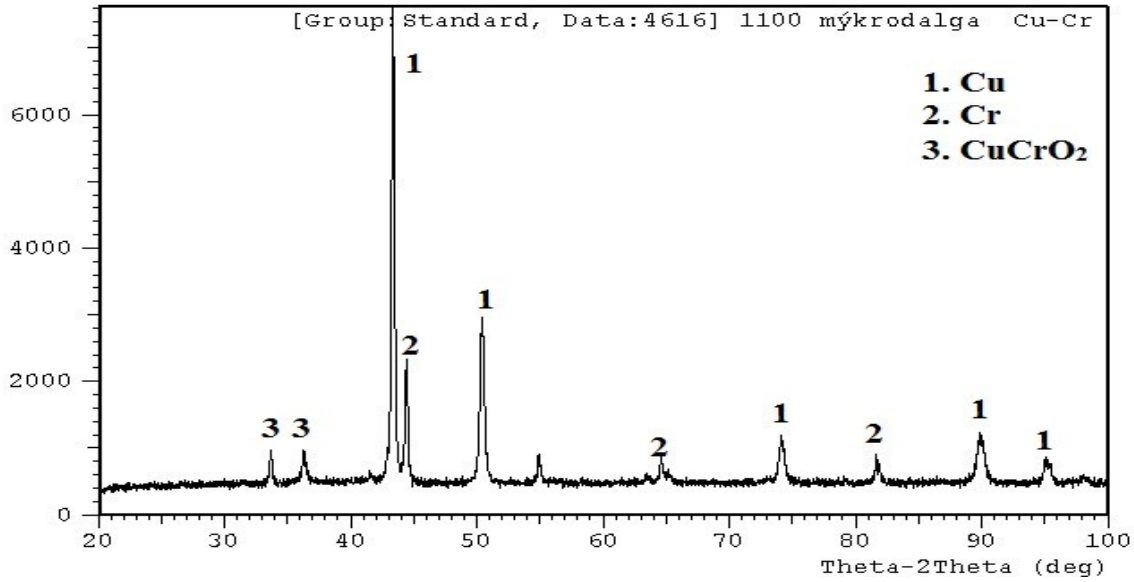

Fig. 6 The XRD analysis results of Cu-Cr composites

Fig. 7 present the XRD analysis results of Cu-Cr-%4SiC composites at 1100°C. The Cu phase, which was the main addition in the composite, has evidently the highest peak intensity over the other phases present in the XRD analysis in the Cu-Cr-%4SiC composites. Fig. 7 which shows the presence of Cu, Cr, SiC and $CuCrO_2$ phases in the fabricated ceramic-metal composites.

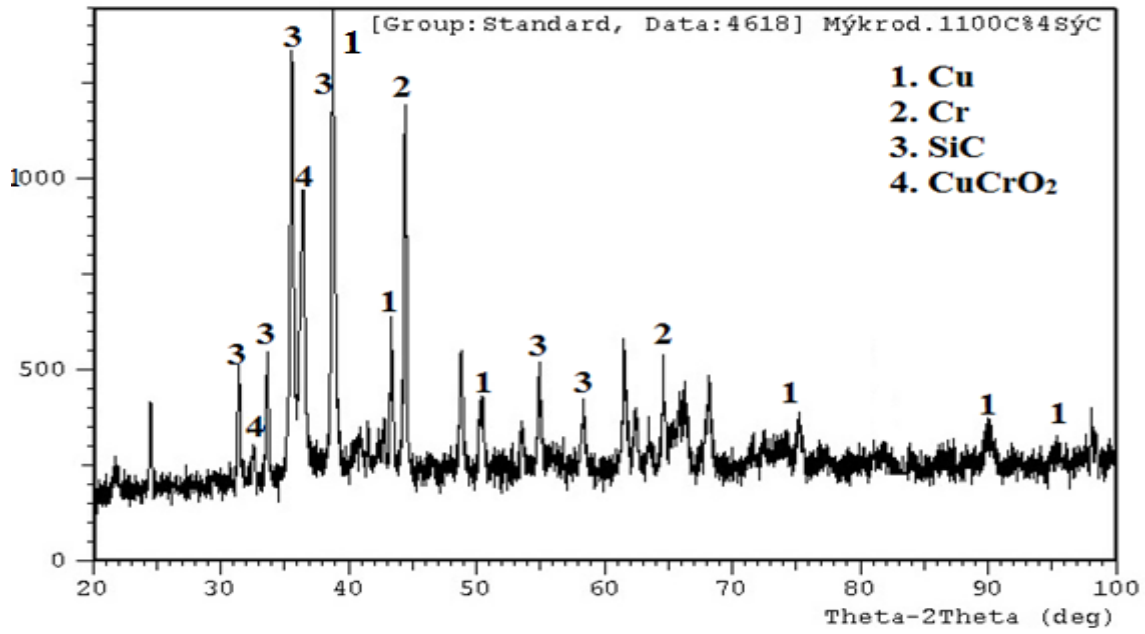

Fig. 7 The XRD analysis results of Cu-Cr-%4SiC composites

CONCLUSİONS

The following results were concluded from the experimental findings

- The highest density in composite made from Cu-Cr-%1SiC powders sintered at microwave furnace was obtained as 1100°C The highest density sample was found as 6, 016gr/cm^3 at 1100°C.
- The highest micro hardness in Cu-Cr-%4SiC composite samples fabricated using powder metallurgy method was found as 183.57HV at 1100°C.
- It was also found out for composition Cu-Cr-%2SiCi at 1100°C suggest that the best properties.

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