MECHANICAL PROPORTIES OF A COMPOSITE PRODUCED FROM ELECTROLESS Ni PLATED Cr AND Ti POWDERS

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Abstract: Intermetallic materials such as NiTi, Ni_3Cr_2, CrTi are among advanced technology materials that have outstanding mechanical and physical properties for high temperature applications. Especially creep resistance, low density and high hardness properties stand out in such intermetallics. The microstructure, mechanical properties of %64Ni plated %32Cr and %4Ti powders were investigated using specimens produced by tube furnace sintering at 1000-1400°C temperature. A composite consisting of ternary additions, a metallic phase, NiTi and Ni_3Ti have been prepared under Ar shroud and then tube furnace sintered. XRD, SEM (Scanning Electron Microscope), were investigated to characterize the properties of the specimens. Experimental results carried out for composition %64Ni plated %32Cr- %4Ti at 1300°C suggest that the best properties as 208HV and 6,87/cm^3 density were obtained at 1400°C

Keywords: Sintering, Intermetallic, Electroless plating, composite

1 Introduction

Electroless Ni plating is a deposition process by which Ni metal ions are transferred onto non-reacting substrate by a reducing agent in the plating solution. It is widely used in aerospace, automotive and electronic industries [1]. To increase its applicability, electroless metal plating of many ceramics has been successfully employed to form a strong binding between particles of ceramics and thus utilize the superior wear and chemical corrosion properties of ceramic phase in highly demanding conditions [2-5]. The coating of WC powders was studied for electroless deposition of Ni and other metals and Ni with P or B and the electrolytic deposition of Ni and onto WC particles and the effect of plating conditions with NiP were also investigated [6-10]. Nickel-based alloys are commonly used as the substructure of metal–ceramic crowns and were introduced into dentistry as a possible replacement for precious alloys due to the increasing cost of gold throughout the 1980s. Ni-based alloys offer the advantage of an increased modulus of elasticity compared with gold that allows thinner sections of the alloy to be used, and consequently less sound tooth destruction during the crown preparation. In addition, the thermal expansion coefficient of Ni-based alloys is well matched to that of conventional veneering porcelain, whichmaintains the metal and ceramic crown to be intimately bonded during firing and prevents cracking of the veneer [11-14].

The Ni–Cr alloys have been shown to be an excellent alternative for noble alloys, for use primarily in metal-ceramic prostheses. The high modulus of elasticity of Ni– Cr alloys, approximately two times higher than the base alloy of gold, allows a reduction in cross-section of the piece, provides more space for the porcelain and less wear on the tooth [15-17]. In spite of the benefits, Ni–Cr alloys have some limitations. The immediate biocompatibility risk with nickel alloys seems to be allergic contact dermatitis. Like all non-precious alloys, nickel alloys are subjected to corrosion products that might lead to soft tissue inflammation and contact dermatitis [18-21].

The purpose of this article is to present the results of an experimental study of the effect of titanium addition on the microstructure and some properties of Ni-Cr alloys. Hardness, density and shear strenght behaviour of the as-cast Ni–Cr–Ti alloys would be evaluated with a hope of developing an alloy suitable for biomedical application

2 Material-Method and Preparation Of Sample

Starting powders employed in this study were as follows Cr powders a particle size lower than 75 μm and the purity of 99.9% for Ti powders with a particle size lower than 150μm. and Cr-Ti-Ni intermetallic composite was produced by electroless Ni plating of Cr-Ti powders.

Ni plating was achieved by suspending the starting Cr-Ti powders in a Ni containing solution ($NiCI_2.6H_2O$) at 90-95°C and by adding Hydrazine Hydrate ($N_2H_4.H_2O$) and 35 vol.% Ammonia solution while keeping the pH at 9-10. With increasing temperature, Ammonia evaporation rate increased rapidly, therefore, a dripper was used to add more ammonia for adjusting pH of the plating solution. In the mean time, the solution was continuously stirred and the pH was constantly monitored by using a Philips PW 9413 Ion-Activity Meter. The reaction was allowed to continue until sufficient Ni was added for plating all the Cr-Ti powders, then, Ni plated Cr-Ti powders were filtered out of the solution by using a paper filter and repeatedly washed off by distilled water and then oven dried at 105°C. and then followed by sintering The composition of %64Ni plated %32Cr-%4Ti specimens was prepared in 10g rectangular compressed pre-form. The Ni plated Cr-Ti powders were shaped by single axis cold hydraulic pressing using high strength steel die. A pressure of 300 Bar was used for the compacting all the powder mixtures. The cold pressed samples underwent for a sintering at 1000, 1100, 1200, 1300 and 1400°C for 2 hours in a traditional tube 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 and Shimadzu Autograph AG-IS 100KN universal tensile tester machine, respectively

Shimadzu XRD-6000 X-Ray Diffraction analyzer was operated with Cu K alpha radiation at the scanning rate of 2 degree per minute. LEO 1430 VP model Scanning Electron Microscope fitted with Oxford EDX analyzer was used for microstructural and EDX compositional analysis.

The volumetric changes of %64Ni plated %32Cr-%4Ti composite 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 temperatures ranging from 1000ºC to 1400ºC in conventional 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 1400°C as 6,87gr/cm^3.

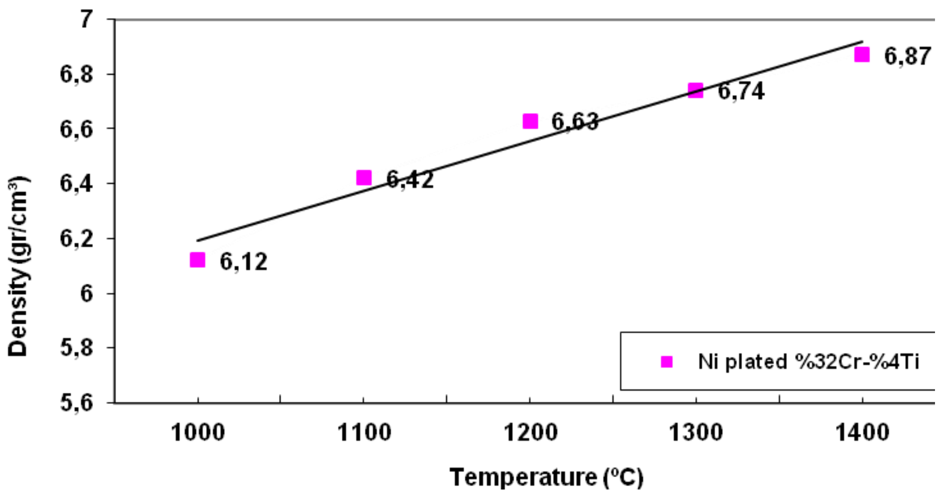


Fig. 1: Density results from sintered specimens treated at different temperatures

The micro hardness-temperature change diagram is shown in figure 2. The micro hardness values of the composite samples produced using conventional sintering technique within the temperature range 1000-1400°C. According to this, the highest micro hardness value in the composite samples produced using powder metallurgy method was observed to be 208HV at 1400°C.

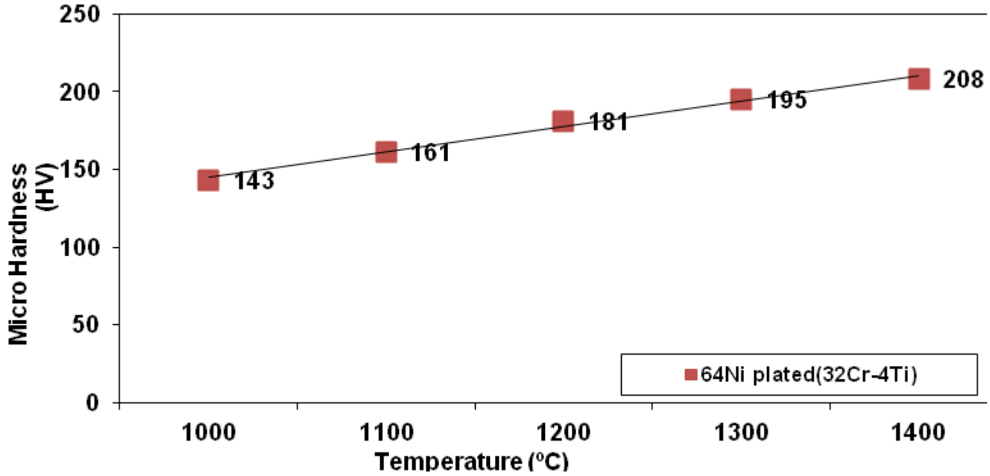


Fig. 2: The micro hardness tests results from sintered specimens treated at different temperatures

Shear strength and hardness of the metal-matrix composite specimens were also determined. The relation between the sintering temperatures and Shear strength values is shown in Figure 3. The shear strength value in the composite samples was observed to be 87.62 MPa at 1400°C.

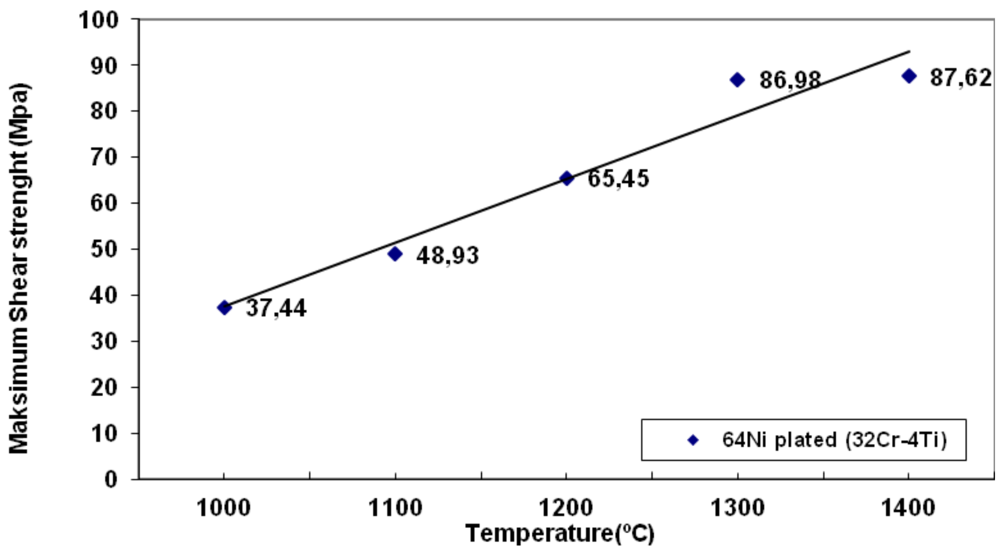
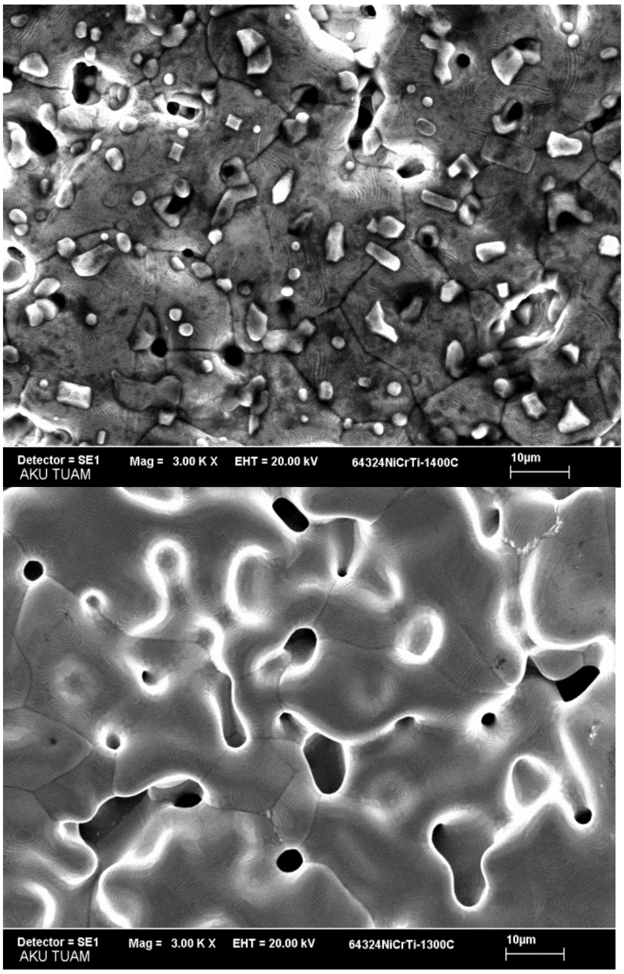


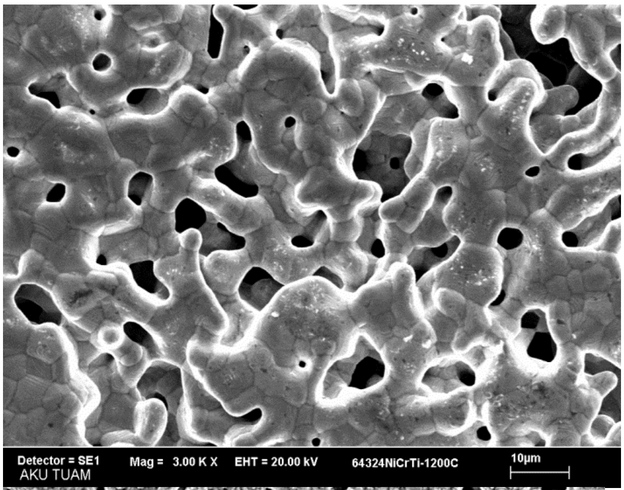
Fig. 3: Shear strength results from specimens sintered at different temperatures

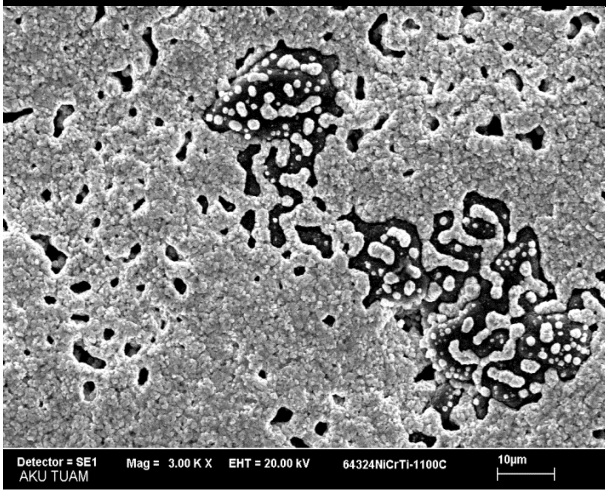
3.1 Metallographic Analysis

The SEM analysis result of the metal matrix composite specimen obtained from Ni plated Cr-Ti powders sintered at 1000 ºC is shown in Figure 4d. grain growth is observed and a homogeneous structure. In Figure 4a, 1400 ºC to become apparent degree of grain boundaries and grain boundaries can be seen that the pores very smaller and circular shapes. Sintering is better understood at 1400 ºC temperature. This density, hardness and shear strength values are confirmed.

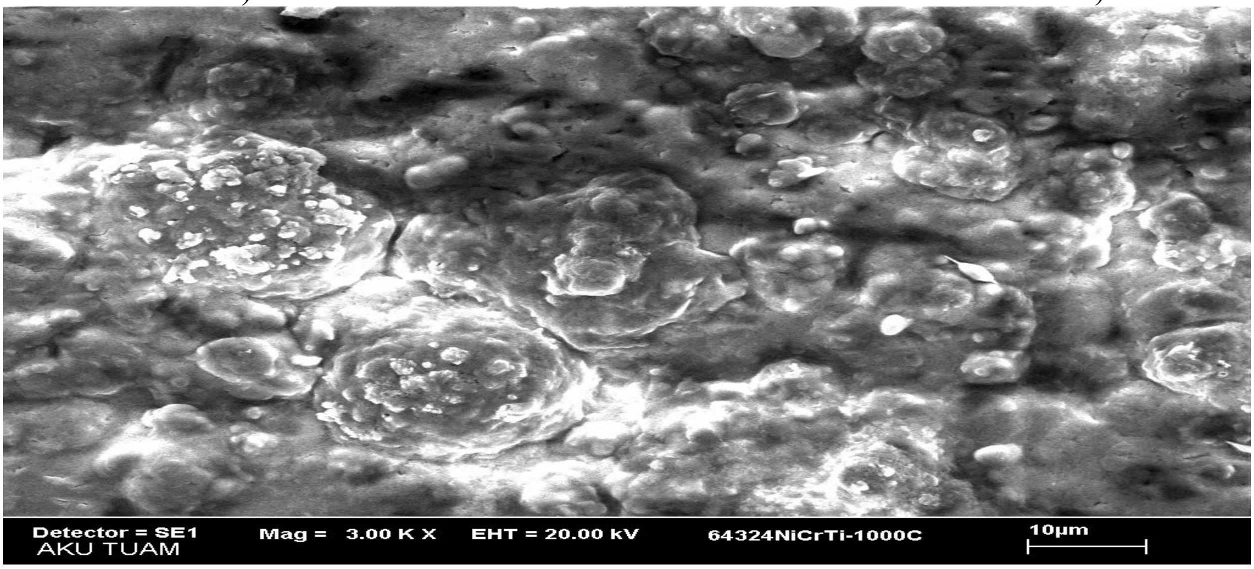


a)1400°C b)1300°C





c)1200°C d)1100°C



d)1000°C

Fig. 4. SEM view of Ni-Cr-Ti composite

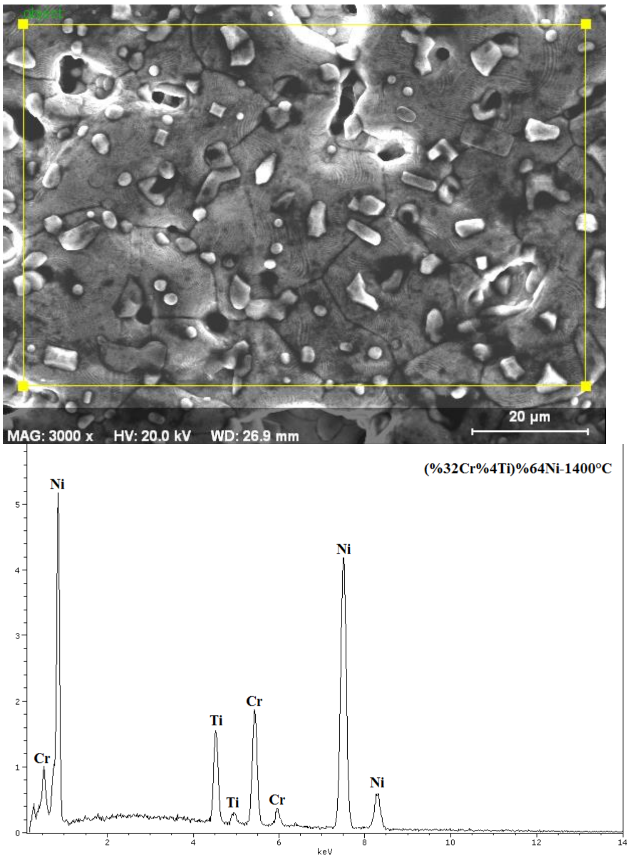


Fig. 5. 1400°C EDX analizi Ni plated (%32Cr-%4Ti)

EDX analysis results are given in Figure 5. Sintered at 1400°C Ni-Cr-Ti composite EDX analysis was conducted of the field. Ni, Cr, Ti elements were identified in the analysis results. The pure Ni element was prepared by coating in the Hydrazine bath.

4. Conclusion

The following results were concluded from the experimental findings

- The highest density in composite made from Ni-Cr-Ti powders sintered at different temperatures was obtained as 1400°C The highest density sample was found as 6,24gr/cm^3 at 1400°C.
- The highest microhardness in Ni-Cr-Ti composite samples fabricated using powder metallurgy method was found as 208HV at 1400°C.

The highest Shear strength sample was obtained as 87,62MPa at 1400°C.

- It was also found out for composition %64Ni plated%32Cr- %4Ti at 1400°C suggest that the best properties.

5. Acknowledgements

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6. References

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