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G. Pesmen, A. Erol, and A. Yonetken

Production of Ni-Cr-Ti-Natural Fibres Composite and Investigation of Mechanical Properties

G. Pesmen[1,a)], A. Erol[2,b)] and A. Yonetken[3,c)]

[1]*Vocational College of Şuhut, Afyon Kocatepe University, Afyonkarahisar, Turkey,*
[2]*Afyon Kocatepe University, Technology Faculty, 03200, Afyonkarahisar/ Turkey*
[3]*Afyon Kocatepe University, Engineering Faculty, 03200, Afyonkarahisar/ Turkey,*
[a)]*gpesmen@aku.edu.tr*
[b)]*aerol@aku.edu.tr,*
[c)] *yonetken@aku.edu.tr*

Abstract. Intermetallic materials such as Ni_2Ti, Cr_2Ti 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 (%50Ni-%48Cr-%2Ti)-%10Naturel Fibres and (%64Ni-%32Cr-%4Ti)-%10Naturel Fibres powders were investigated using specimens produced by tube furnace sintering at 1000-1200-1400°C temperature. A composite consisting of ternary additions, a metallic phase, Ti,Cr and Ni 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-%32Cr-%4Ti)-%10Naturel at 1400°C suggest that the best properties as 112.09HV and 5,422g/cm^3 density were obtained at 1400°C

Keywords: Sintering, Naturel Fibres, high temperature, composite
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INTRODUCTION

The intermetallic phases of Chromium, nickel and titanium with alumnium are the subject of research interest of many scientific centers and they are being manufactured by powder metallurgy method and applied more widely nowadays. [1]. Geometry and surface topography are crucial for the short- and long-term success of dental implants. [2]. Many properties of the alloys originate from the crystallographic nature of cobalt, the solid solution strengthening effect of chromium and alloying elements, the formation of extremely hard carbides and the corrosion resistance imparted by chromium [3-5]. The defects of dental cast alloys include mainly shrinkage porosity, inclusion, micro-crack and dendritic structure. Only few reported works were available on the influence of casting procedures on the corrosion resistance of dental alloys [6-9].

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.

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Hardness and corrosion behaviour of the as-cast Ni–Cr–Ti-%10NF alloys would be evaluated with a hope of developing an alloy suitable for biomedical application.

MATERIAL-METHOD AND PREPARATION OF SAMPLE

Starting powders employed in this study were as follows: the purity of 99.8% for Ni powders with a particle size lower than 40 μm, the purity of 99.95% for 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. The composition of (%50Ni-%48Cr-%2Ti)-%10Naturel Fibres powders and (%64Ni-%32Cr-%4Ti)-%10Naturel Fibres powders specimens were prepared in 5g cylindrical 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 300 Bar was used for the compacting all the powder mixtures. The cold pressed samples underwent for a sintering at 1000, 1200, 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 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 (%50Ni-%48Cr-%2Ti)-%10Naturel Fibres powders and (%64Ni-%32Cr-%4Ti)-%10Naturel Fibres 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.

EXPERIMENTAL RESULTS AND DISCUSSION

Characterization of Specimens

In the study, the samples prepared and shape were sintered at temperatures ranging from 1000ºC, 1200°C and 1400ºC in conventional furnace and made ready for physical, mechanical and metallographic analyses. Density-temperature change curve is shown in Figure 1. The composition of (50Co-48Cr-2Ti-)%10NF highest sintered density was achieved at 1400°C as 5,622g/cm^3.

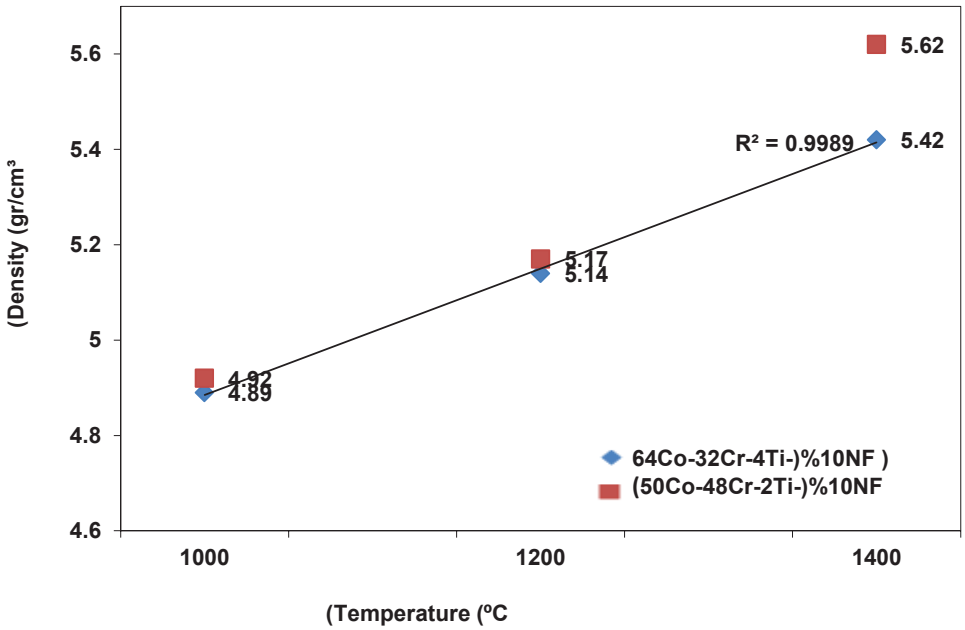

FIGURE 1. The density change with respect to sintering temperature

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 1000ºC, 1200°C and 1400ºC. According to this, the highest micro hardness value in the composite samples of (%50Ni-%48Cr-%2Ti)-%10Naturel Fibres produced using powder metallurgy method was observed to be 327.76HV at 1400°C.

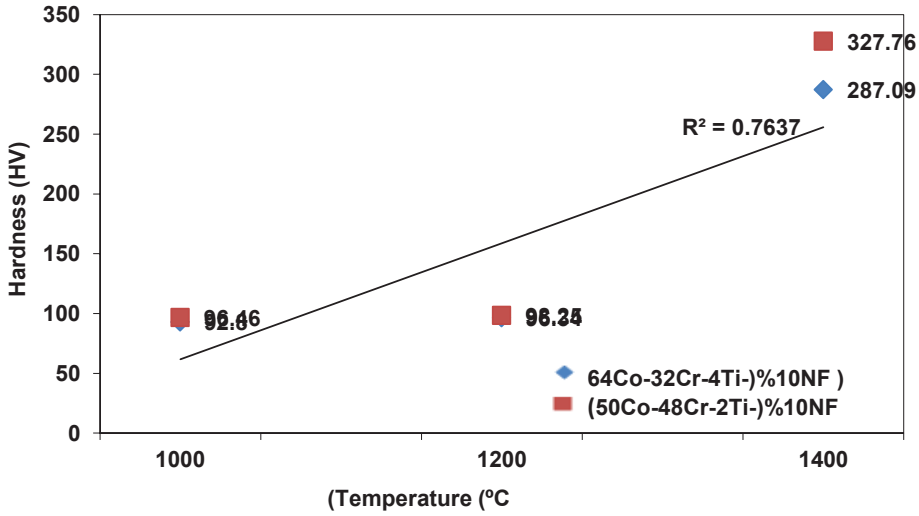

FIGURE 2. The micro hardness tests results from sintered specimens treated at different temperatures

Metallographic Analysis

The SEM analysis result of the metal matrix composite specimen obtained from (Ni-Cr-2Ti)-%10NF powders sintered at 1400 ºC is shown in Figure 3. grain growth is observed and a homogeneous structure and grain boundaries can be seen that the pores very smaller and different shapes. (Ni-Cr-4Ti)-%10NF powders sintered at 1400 ºC is shown In Figure 4, 1400 ºC to become apparent degree of grain boundaries and Sintering is not better understood at (Ni-Cr-2Ti)-%10NF composition at 1400 ºC temperature. This density, and hardness values are confirmed.

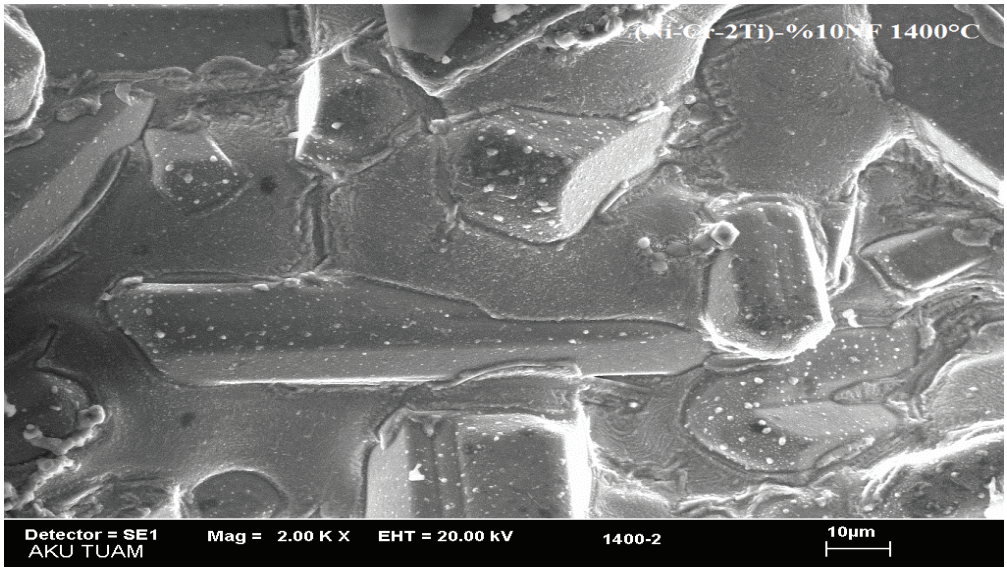

FIGURE 3. SEM view of (Ni-Cr-2Ti)-%10NF composite 1400°C

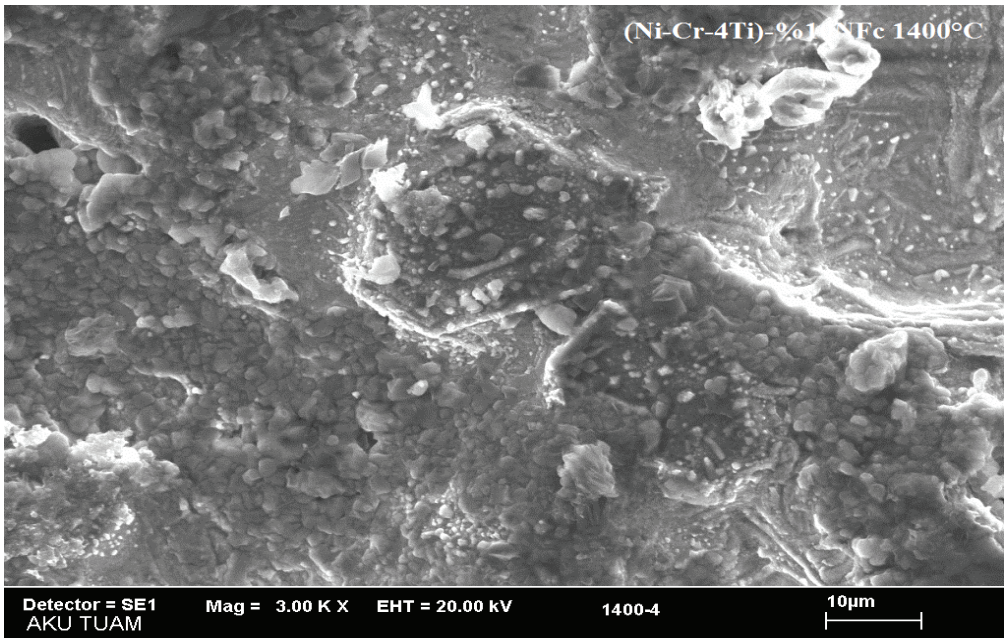

FIGURE 4. SEM view of (Ni-Cr-4Ti)-%10NF composite 1400°C

XRD Analysis

In Figure 5, NiTi, Cr_2Ti, Ni_2Ti,Ni and Ti peaks can be seen in the XRD analysis from (Ni-Cr-%2Ti)-%10 Natural Fibres and (Ni-Cr-%4Ti)-%10 Natural Fibres composite sintered in tube furnace at 1200°C

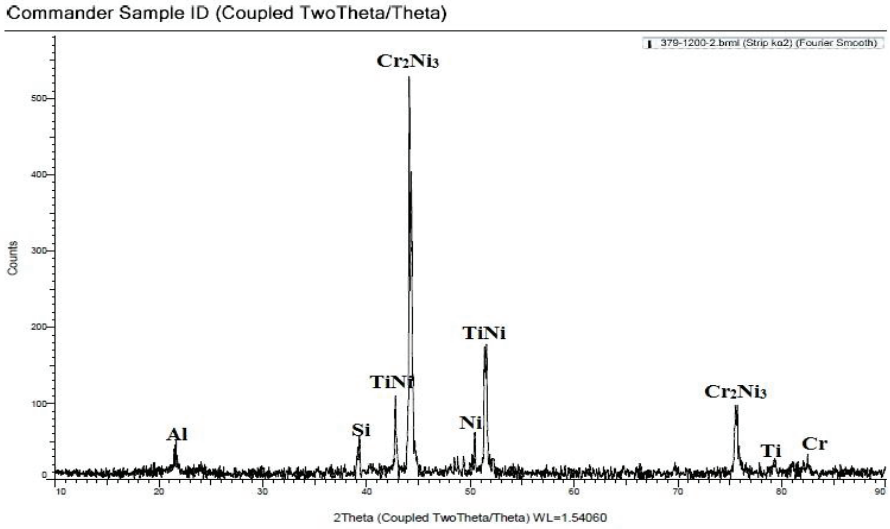

FIGURE 5. The XRD analysis (Ni-Cr-2Ti)%10NF composite Sintered in tube furnace at 1200°C

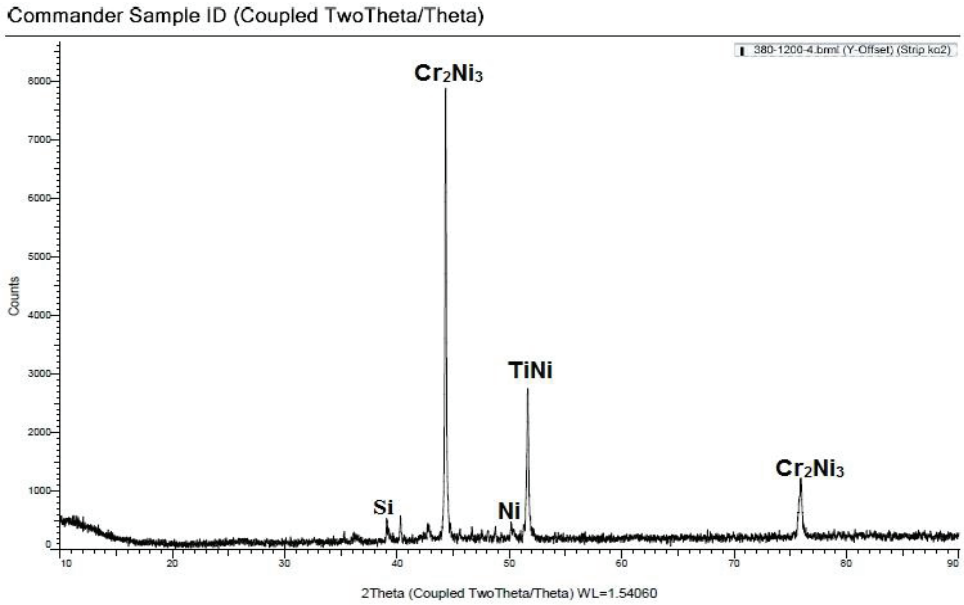

FIGURE 6. The XRD analysis (Ni-Cr-4Ti)%10NF composite Sintered in tube furnace at 1200°C

Ni-Cr-Ti powders were mixed and then sintered in a conventional furnace. After sintering, a considerable drop in the mechanical properties of specimens sintered at 1000ºC, 1200°C and 1400ºC were observed. It was concluded that Ni-Cr-Ti particles were occured by TiNi Cr_2Ni_3, and Ni_3Ti intermetallic phase at 1200°C (Fig. 6) and Hardness test results suggest that (Ni-Cr-4Ti)-%10NF composite sintered at 1400°C shows Vickers micro hardness values respectively.

CONCULUSION

The following results were concluded from the experimental findings

- The highest density in composite made from Ni-Cr-Ti-%10NF powders sintered at different temperatures was obtained as 1400°C The highest density sample was found as 5, 42gr/cm^3 at 1400°C.
- The highest microhardness in (%50Ni-%48Cr-%2Ti)%10NF composite samples fabricated using powder metallurgy method was found as 327HV at 1400°C.
- It was also found out for composition (%50Ni-%48Cr- %2Ti)%10NF at 1400°C suggest that the best properties.

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