Teeth of Implant Production And Characteristics By Using Ti-Cr-Co Powders

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Abrasct - As it is known, a material must be biocompatible in order to be classified as biomaterial. In order for materials to be biocompatible, they must pass in vivo and in vitro tests. Mechanical and chemical tests such as abrasion, compression, tensile and corrosion resistance as well as body-material compatibility and behavior of the material within the body are included in these tests. In this study, in vivo and in vitro tests of biocompatibility tests were theoretically examined.

Index Terms- Biocompatibility, Biomaterials, Biometal, Implant, Dentistry, Mechanical Experiments, Intermetallic

1 Introduction

Biocompatibility is defined as the ability to create a biological response to a region where a material is applied. The traditional approach to biocompatibility refers to the fact that the material does not have significant side effects on body tissues. A more correct approach is to "select or produce materials in chemical form that will exhibit a harmonious interaction with the surrounding biological environment [1].

Different steps for biological tests and appropriate test methods are described. Initiation experiments reveal the toxic profile of the material by hemolysis, cellular and systemic toxicity methods. Secondary tests include in vivo implantation studies, oral mucous membrane irritation or sensitization tests. Finally, the clinical performance of the material in its actual use is assessed [1].

The testing of the biological properties of the materials is usually started with simple in vitro test methods using cell cultures. Evaluations are continued with animal tests, and when the desired results are obtained from these tests, more extensive studies such as in-vivo assessments should be undertaken [2].

2 CLASSIFICATION OF BIOMATERIALS

2.1 Metals

Metals are the most commonly used biomaterials because of their high strength, high fatigue resistance, and inability to undergo plastic deformation prior to fracture, as well as good electrical and thermal conductivity and mechanical properties. Some metals are used as passive substitutes in hard tissue treatments such as total hip and knee joints, plaques and screws used to heal bone fractures, spinal fixation devices and dental implants due to their excellent mechanical strength and resistance to corrosion. Some metal alloys are also used in vascular stents, catheter guide ties, orthodontic arc ties and cochlear implants. The biocompatibility of metallic implants is highly controversial. Because these implants can undergo corrosion in the body. As a result of corrosion, the implant material spontaneously degrades and corrosion affects the surrounding tissues and organs. [3]

a Surgical Stainless Steel

Stainless steels for surgical purposes are Fe-Cr-Ni alloys. Chromium increases both the corrosion resistance and the heat resistance. The earlier used 18/8 steel was replaced by the more commonly used 316L alloy today. The internal structure of 316 and 316L alloys, widely used as implant materials, is austenitic. 316L contains less carbon. Corrosion resistance has been improved by reducing the carbon content. The chromium layer formed on the surface increases the usability of this steel by providing passivation. The passive layer formed on the surface is not as strong as the titanium and cobalt alloys. [4]

b Titanium Based Alloys

Titanium is sharper than 316L stainless steel and cobalt alloys. Most Ti6Al4V alloy is used. The biocompatibility of titanium allows long-lasting implants because the corrosion resistance is high and the modulus of elasticity of the elasticity module is close to the modulus of elasticity of the bone. The densities are low (4.5 g / cm3). Their properties can be improved by heat treatment. [4]

c Cobalt Based Alloys

These alloys are cobalt-chromium and cobalt-chromium-nickel-molybdenum alloys. They contain 65% cobalt by weight. Molybdenum improves mechanical properties by

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International Journal of Scientific & Engineering Research Volume 9, Issue 8, Augsut-2018
ISSN 2229-5518

providing a fine-grained structure. Co-Cr-Ni-Mo and Co-Cr alloys are used in prostheses of more load bearing joints such as knees and hips. Elasticity module is bigger than stainless steel. Co-Cr-Mo alloy casting alloy, molybdenum is added to obtain a finer grain structure. Molybdenum addition increased the strength. Chromium also increases the strength by making solid solution. The hot-forged Co-Cr-Ni-Mo alloy has superior wear, fatigue and tensile strength. The fatigue strength is also higher than the Ti 550 alloy. Cast and forged alloys have high corrosion resistance. [4]

d Tantalum Based Alloys

The tantalum elasticity modulus is close to the modulus of elasticity of your bone. Corrosion resistance and biocompatibility are very good. It is an implant material that is used for porous construction. The mechanical strength is low. Mechanical properties can be increased by alloying. It limits the use of high density. The most important application is the use of plastic surgery as a surgical thread. [4]

e Dental Amalgam

Amalgam is an alloy of mercury, one of its components. It is used as tooth filling material. Others; gold, platinum and nickel-titanium alloy. Gold is a noble metal and has high corrosion resistance. Mechanical properties are improved by alloying. It is used as coating material in dentistry. Platini. corrosion resistance is high, but mechanical properties are low. Platinum and other noble metals are used as electrodes in the autonomous center, which stimulates the onset of heart attacks. Ni-Ti alloys are shape memory alloys. Dental bridges are used in skull vein connections, artificial heart contractions and orthopedic prostheses. [4]

2.2 Polymers

The most important group of biomaterials is polymeric biomaterials. Polymers are widely used in many medical applications such as prosthetic materials, dental materials, covering materials, implants, drug release systems and tissue engineering products. [3]

a Polyethylene (PE)

High-density polyethylene (HDPE) is often used in medical applications. This is because the temperature generated during sterilization is a low density polyethylene dissolution. PE is used in plastic surgeons, catheters and artificial hip prostheses. Low cost and resistant to oils. [5]

b Polypropylene (PP)

Similar properties to polyethylene. It is a tougher polymer, and polypropylene can be used in many applications where polyethylene is used. [5]

c Polymethyl methacrylate (PMMA)

It is a hydrophobic polymer. It is glassy at room temperature. Lucite and Plexiglas are known by their trade names. It is used in the production of intraocular lenses and contact lenses due to its light transmittance and stability. The hydrogel form containing cross-linking is obtained by various processes. This form is resistant to degradation and is not absorbed by the body. [5]

d Polyvinylchloride (PVC)

It is used medically in the form of a tube in blood transfusion, dialysis and nutritional applications [5]

e Polyurethane (PU)

They are highly compatible with blood and are therefore preferred for artificial cardiac and vascular applications. [5]

f Polycarbonate (PC)

Polymerization of bisphenol A and phosgene is finally synthesized. It has high stamina because it is a hard material. It is used in glasses, in heart-lung machines and in respiratory devices. [5]

g Polytetrafluoroethylene (PTFE)

It is best known for its commercial name: Teflon. It is a very stable, difficult-to-handle and hydrophobic material. It has high slipperiness. Forms known as Gore-Tex are used in vascular prostheses. [5]

h Polylactic Acid (PLA)

They are rigid thermoplastic and aliphatic polymers in semicrystalline or amorphous form. It is used as a biodegradable artificial tendon piece, as well as in stent applications for connective tissue, tendon structures, vascular and urological surgery. [5]

2.3 Ceramics

Controlled implantation of bioceramics in clinical practice began with the use of porcelain in the tooth crowns in the 18th century and continued in the 19th century with the use of gypsum or gypsum to fill the bone in the orthopedic. With the advancement of ceramic technology in the 20th century, more advanced ceramics used in medical applications became available. Bioceramics are generally divided into two groups as 'bioactive' (calcium phosphate, glass, ceramics etc.) and 'bioinert' (alumina, zirconia, pyrolytic carbon, etc.). [3]

a Aluminina

Due to its high density and high purity (> 99.5%) alumina, corrosion resistance, high strength and good biocompatibility, it has widespread use in hip dentures and dental implants.

International Journal of Scientific & Engineering Research Volume 9, Issue 8, Augsut-2018
ISSN 2229-5518

The alumina used in these applications has a large grain structure polycrystalline alpha-Al_2O_3 is obtained at a temperature of 1600-1700 °C. as the sintering temperature. Alumina is used for more than 20 years in orthopedic applications. [6]

b Zirconia

Zirconia (ZrO_2) also has an inert effect on the physical environment, such as alumina. Zirconia, which has a much higher cracking and bending resistance, is successfully used in thigh-bone prostheses. However, there are three important problems in their implementation; Decrease in tensile strength due to physiological fluids over time, weak coating properties and potentially radioactive materials. Zirconia has radioactive elements (uranium, thorium, etc.) that have a very long lifetime. Separating these elements from the structure is very difficult and requires expensive operations. Radioactivity occurs as alpha and gamma interaction, and alpha particles have the potential to destroy soft and hard tissue cells, as they have high ionization capacity. Long-term results of this effect should be examined when the level of radioactivity is low. [6]

c Calcium-Phosphate (Ca-P) Ceramics

It is made in the form of multiple oxides of calcium and phosphate atoms. Hydroxyapatite (HA: $Ca_{10}(PO_4)_6(OH)_2$), Tricalcium phosphate ($Ca_3(PO4)_2$) and Octakalium phosphate ($CaH(PO_4)_3.2OH$). Calcium phosphate based bioceramics have been used for 20 years in dentistry and dentistry. These materials are used as "bone dust" in orthopedic coatings and dental implants, face bones, ear bones, hip and knee prostheses. The sintering of calcium phosphate ceramics occurs usually at 1000-1500 ° C followed by compression to the desired geometry. All calcium phosphate ceramics are biodegradable at varying rates. Another application of hydroxyapatite bioceramics is ocular implant application. Properties such as biocompatibility and non-toxicity make an ideal biomarker for hydroxyapatite ocular implant application. [6]

d Glass And Glass-Ceramics

The glasses are silica (SiO_2) based materials. Glass ceramics, glass containing Lithium / Aluminum or Magnesium / Aluminum crystals. In biochemistry, some of the silica groups have been replaced by calcium, phosphorus, or sodium (SiO_2, Na_2O, CaO, P_2O_5). Thus, chemical bonding occurs between the tissue-implant. Bioactive glasses were first developed by Hench et al. [6]

3 TESTS

In the past, biocompatibility assessments of materials have been used on humans. Today, however, it is necessary to evaluate the biocompatibility with a wide range of tests before a new material can be applied in humans. The testing of biological specimens of materials is usually started with simple in vitro test methods in which cell cultures are used. The advantages and disadvantages of the tested tests are shown in Table 1. [2]

Table 1. Advantages and disadvantages of biocompatibility test methods [2]

Test	Advantages	Limitations
İn vitro	Quick application Lower costs Standardized Ability Easy control in test environment Broad scale evaluation	Relationship with the environment is controversial
Animal tests	Be able to detect complex widespread interactions More realistic and more comprehensive than in vitro tests	Interactions with the materials used are controversial Ethically controversial Obtaining difficult-to-evaluate results
Usage tests	Determination of the relations of the materials used with the tissues	Duration is long High cost More controversial in terms of ethics Difficult to control

4 MATERIALS CREATE IN THE HOUSING-WISDOM EFFECTS

4.1 Biotoler Effect

Biomaterials are said to affect biotolerance when surrounded by restricted fibrous tissue. This is seen in most biomaterials used today. [9]

4.2 Bioinert Effect

The biomarker merges with the bone tissue applied, without the occasional fibrous tissue. Often, biomaterials are in an effort to influence the material applied to them in tissues. The bioinert effect is the biomaterial-tissue relationship that such interactions are not seen. Numerous researchers believe that bioinert is not actually a biomarker. [9]

4.3 Bioactive Effect

Biomarking can be said to be bioactive if it helps in the formation of similar cells in the tissue being applied. [9]

4.4 Toxic Effect

Biomaterials used in orthopedics and traumatology have been put into use since they have passed many tests and biocompatibility has been confirmed. Despite all these tests, biomaterials may have allergic, immunological, nonimmune, muta-

International Journal of Scientific & Engineering Research Volume 9, Issue 8, Augsut-2018
ISSN 2229-5518

genic, carcinogenic and inflammatory effects. [9]

5 Results

5.1 Preparing Samples

44 μ size, with a purity of 99.5% and a volume of 80% of Ti powder; 44 μ size, with a purity of 99% Cr powder and a size of 149 μ, with a purity of 99.9% Co powder to a volume of 5%, and stirred for 1 day. The steel mold is pressed and pressed by a single axis hydraulic press. At 900 ° C, 1000 ° C, 1100 ° C, 1200 ° C, 1300 ° C for 2 hours in an argon gaseous controlled atmosphere and cooled to 300 ° C.

5.2 Metallography

(a) (b) (c) (d) (e)

Figure. 5.1. Sample formed at (a) 900 ° C (b) 1000 ° C (c) 1100 ° C; (d) 1200 ° C; (e) 1300 ° C.

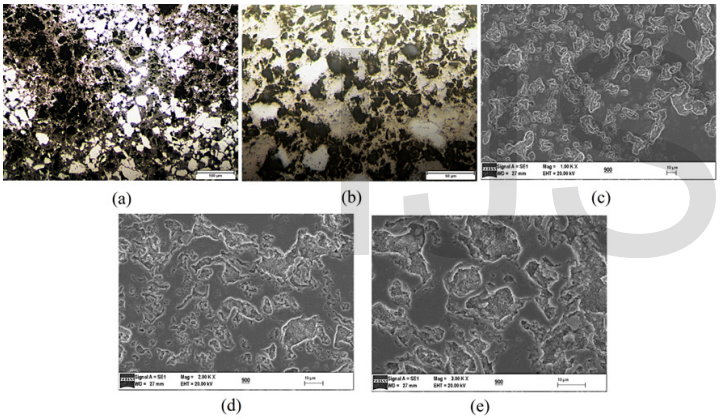


Figure 5.2. At 900 ° C (a) 200 magnifications (b) 500 magnifications (c) 1000 magnifications (d) 2000 magnifications (e) 3000 magnifications

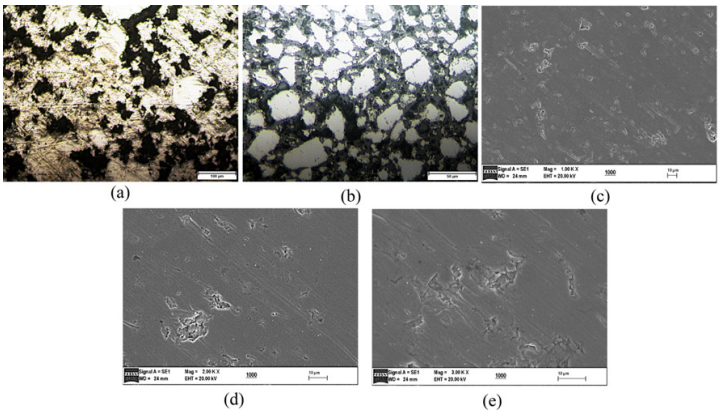


Figure 5.3. At 1000 ° C (a) 200 magnifications (b) 500 magnifications (c) 1000 magnifications (d) 2000 magnifications (e) 3000 magnifications

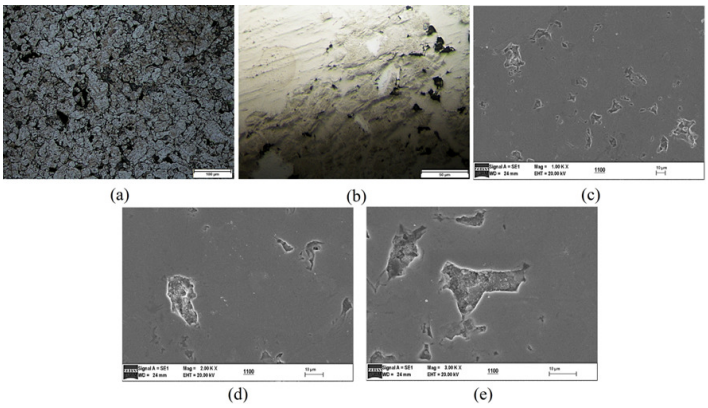


Figure 5.4. At 1100 ° C (a) 200 magnifications (b) 500 magnifications (c) 1000 magnifications (d) 2000 magnifications (e) 3000 magnifications

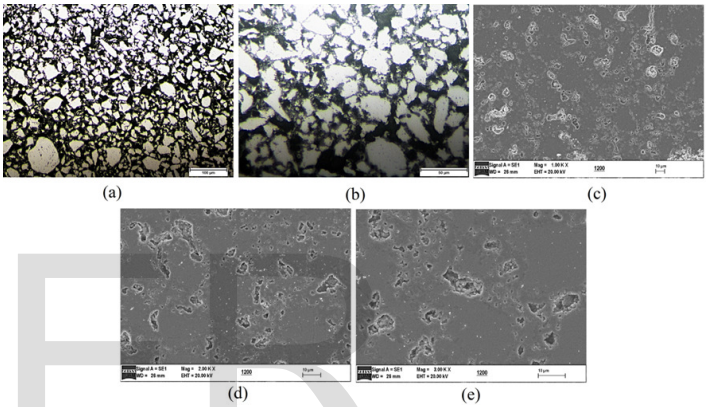


Figure 5.5. At 1200 ° C (a) 200 magnifications (b) 500 magnifications (c) 1000 magnifications (d) 2000 magnifications (e) 3000 magnifications

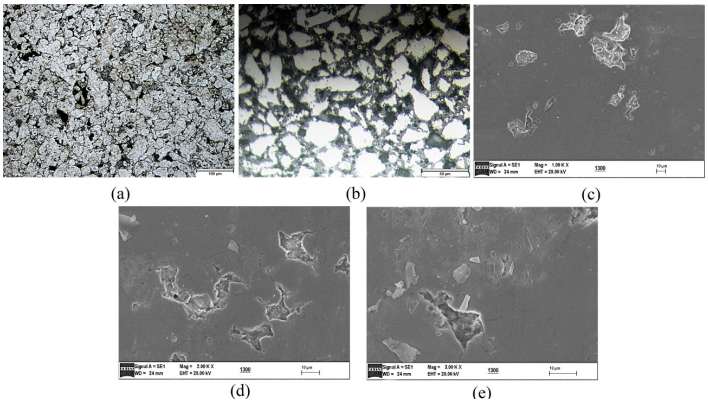


Figure 5.6. At 1200 ° C (a) 200 magnifications (b) 500 magnifications (c) 1000 magnifications (d) 2000 magnifications (e) 3000 magnifications

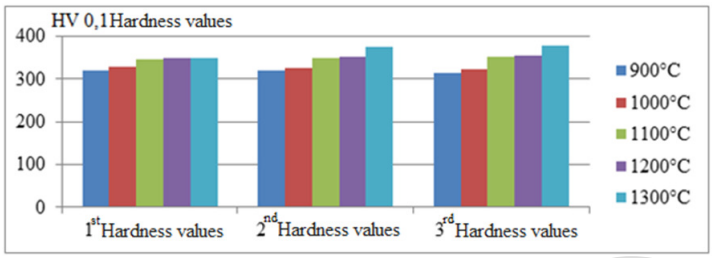
International Journal of Scientific & Engineering Research Volume 9, Issue 8, Augsut-2018
ISSN 2229-5518

5.3. Hardness Test

Test results measured with HV 0.1 (load, 100 grams-time, 10 seconds.)Table 5.1 below, in Graphic 5.1.

Table. 5.1. Hardness test results

Temperature of the sample	1. Hardness value	2. Hardness value	3. Hardness value
900°C	319,12	319,67	314,53
1000°C	328,91	325,85	323,63
1100°C	347,32	349,15	351,33
1200°C	347,91	352,45	353,95
1300°C	349,92	376,21	379,582



Graphic 5.1. Hardness values

5.4 Wear Test

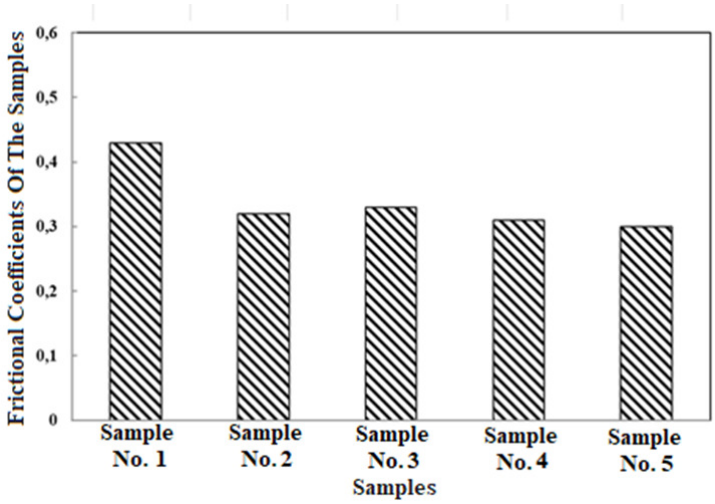
The wear test was applied by Ball-On-Disk method. The road is 300 meters, the load is 5 newtons, the track diameter is 12 mm. Wear speed = Wear volume / (Load applied x Slide distance), found in mm3 / Nm formula.

Table 5..2. The pre-and post-wear weights of the samples and the weight losses. (in g)

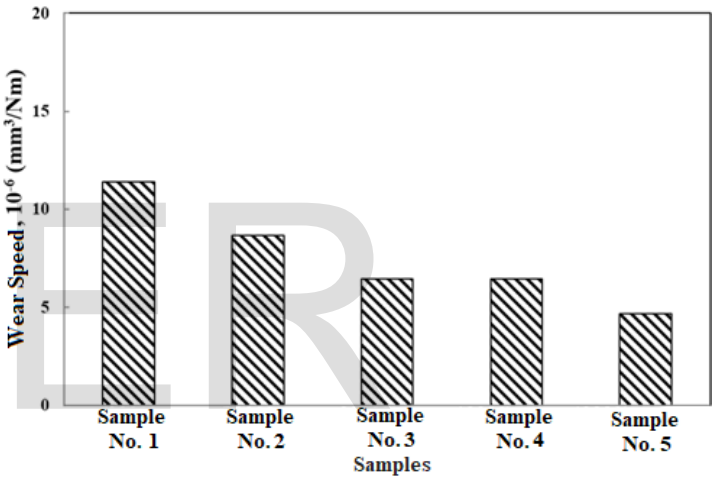
The Temperature of the Samples	Starting Weight (g)	Final Weight (G)	Weight loss (g)
900°C	4,37	4,36	0,01
1000°C	5,28	5,26	0,02
1100°C	5,56	5,55	0,01
1200°C	5,42	5,40	0,02
1300°C	5,64	5,63	0,01

Table 5.3. Frictional coefficients and wear rates of the samples

The Temperature of the Sample	Friction Coefficient	Wear Rate x 10-6 (mm3 / Nm)
900°C	0,43	4,12
1000°C	0,32	4,26
1100°C	0,33	3,94
1200°C	0,31	4,38
1300°C	0,30	3,99



Graphic 5.2. Frictional coefficients of the samples

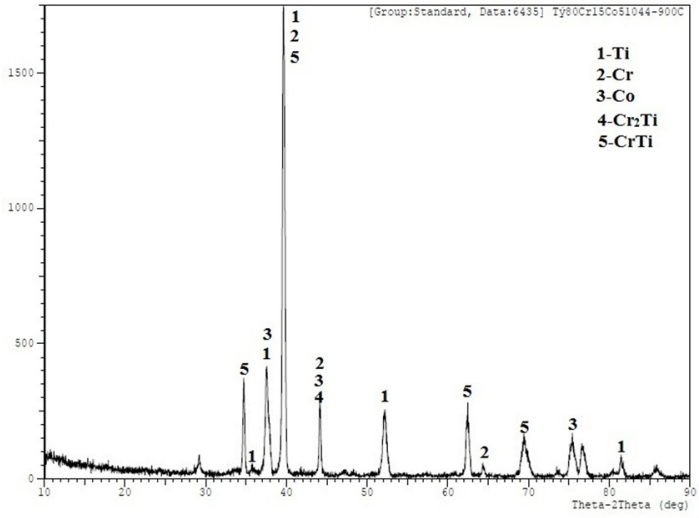


Graphic 5.2. Frictional wear speeds of samples

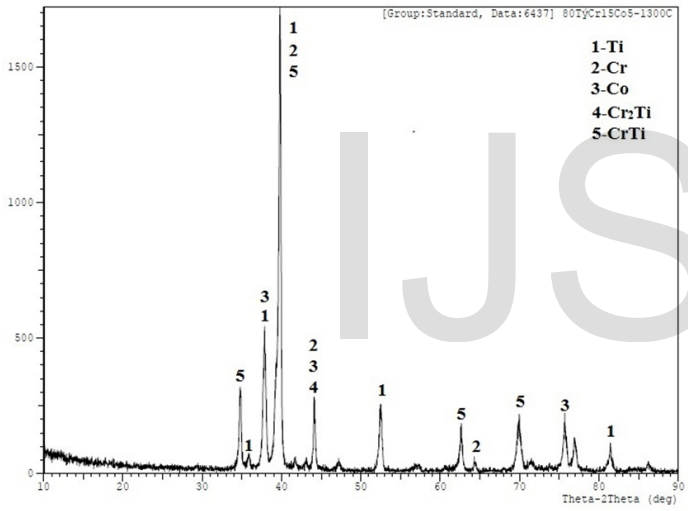
5.5 XRD Modifications and Results

Each crystal phase is based on the principle of breaking X-rays in a characteristic order due to their specific atomic arrangement. For each crystal phase, these diffraction profiles define the crystal as a kind of fingerprint. The X-Ray Diffraction analysis method does not destroy the sample during analysis and allows analysis of even very small samples.

International Journal of Scientific & Engineering Research Volume 9, Issue 8, Augsut-2018
ISSN 2229-5518



Graphic 5.3. XRD results of the sample held at 900 ° C



Graphic 5.4. XRD results of the sample held at 1300 ° C

5.6 RESULTS-SOLUTIONS-ADVICE

Only the hardness and abrasion test data were evaluated in the experimental studies. In addition to this experiment, there are experiments to determine the important strength properties of the part, such as compression test, but it is not possible that the test equipment is defective. Friction coefficients were investigated by weight loss in the wear test and it was determined that the friction coefficients with losses are close to each other as close as possible to each other. Prior to experimental work, mechanical mixing, which is carried out at the stage of powder mixing, if it is done for a longer time, a more homogeneous powder mixture may be obtained and fluctuations in the results of the experiment may be achieved. By using a more complicated device that both presses and heats the same, the mechanical properties can be improved within the possibilities of better adhesion of the powder particles to each other and accordingly a less porous structure. The particle size of the spent powders can be reduced to increase the spreading efficiency between the particles. If the grain sizes and purity of the powders are the same, the undesirable compounds (oxides, intermetallics) and states (micro-cracks, higher than necessary pores) can be removed.

Generally speaking, in the selection of biomaterials; biocompatibility, toxic effect, stretch-to-stretch resistance to use, resistance to corrosive effects of body fluids, and the like. Especially 20th century. From the beginning the biomedical field has been in great improvement. Many artificial materials compatible with the human body have been developed. For the selection of biocompatible materials, the above information on the biocompatibility of the materials should be considered. Firstly, the material should be selected to have the proper strength according to the place of use. Before applying it later, the allergic structure of the person against the materials to be used must be examined by specialist doctors with various allergy tests. The biomaterials to be used should be tested for their corrosion compatibility in biological formulations in solutions to be prepared in, or in close proximity to, samples from body fluids. The tissues inside the body are generally; hard tissues and soft tissues. Examples of hard tissues include bones, teeth, etc. Examples of soft tissues include blood vessels, skin, tendons. Given the structural compatibility, metals and / or ceramics are suitable for hard tissue applications, polymers for soft tissue applications. Hardness values, wear values; It matches the digger information in the literature. In addition, TiCr2 and TiCr intermetallics are formed in the structure as seen in the XRD graphs.

REFERENCES

[1] İsmail Hakkı Uzun, Funda Bayındır (2011), Dental Materyallerin Biyouyumluluk Test Yöntemleri, S.116
[2] Safa Tuncer, Mustafa Demirci (2011) Dental Materyallerde Biyouyumluluk Değerlendirmeleri, S.141
[3] Öznür Özsoy, (2010), Etken Madde İçeren Kemik Çimentolarının Hazırlanması ve Karakterizasyonu, Yüksek Lisans Tezi, Hacettepe Üniversitesi, Fen Bilimleri Enstitüsü, Ankara, S. 3-14
[4] Kamil Delikanlı, Şevki Yılmaz Güven, (2006), Metalik Biyomalzemelerde Son Gelişmeler, S.368 369
[5] Berat Mert İzgi, Mehmet Seyit Zor, (2013), Biyopolimerlerin Ortopedik Uygulamaları, S.3
[6] Ahmet Pasinli, Biyomedikal Uygulamalarda Kullanılan Biyomalzemeler, S. 31-32
[9] A. Kaya Gür, Mustafa Taşkın, (2004), Metalik Biyomalzemeler ve Biyouyum, S. 111