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Production of hydroxyapatite reinforced with silicon carbide

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Abstract
In this study, hydroxyapatite and hydroxyapatite reinforced with silicon carbide was produced, the results obtained were mentioned and documented. Materials with and without hydroxyapatite were produced and it was aimed to give an idea about the properties of composite materials by performing compression tests for these two types of materials produced. Since hydroxyapatite is compatible with biomaterials, it has been shown how important hydroxyapatite is in this area.

Keywords: Silicon Carbide, Hydroxyapatite, Composite Materials, Production

1. Introduction

Today, the production of composite material, which has a very widespread use in almost every area from shipbuilding to building construction, from the production of home appliances to space technology, seems to have appeared in the past few hundred years. However, the introduction of the concept of composite material and the handling of the subject as an engineering subject occurred only in the early 1940s. The first examples of multi-component material are the stage where it is started to be made usable by the interventions made to the material found in nature. Since the early ages, people had been worked on absorbing this fragility feature by putting vegetable or animal fibers into fragile materials. One of the best examples of these issues one is adobe material. Stems and fibers, such as straw, ivy branches, which are added to clay mud in mud brick production, increase the strength of the material during both production and use. Biomaterials are materials used to perform or support the functions of organs and tissues in the human body, and are divided into 4 main groups: metals, ceramics, polymers and composites. [1] The most important feature in biomaterials is body compatibility (biocompatibility), and are materials that do not interfere with the normal changes of the surrounding tissues and do not cause side effects (inflammation, clot, etc.) in the tissue. Hydroxyapatite is the enamel and dentin layer of the teeth and calcium powder in the bone. It does not burn, as it does not react with oxygen. It is the hardest molecule known after diamond in nature. It cannot be abraded with steel burs or sanding, only with diamond degradable. It is less flexible, almost completely fragile. It is a bioactive biomaterial. It is tasteless and odorless. It is insoluble in organic solvents. Among the most important features of hydroxyapatite is its excellent biocompatibility. Hydroxyapatite forms a chemical bond directly with hard tissues. [2-5] In placing the hydroxyapatite particles or porous blocks in the bone, the new tissue is formed in 4-8 weeks. The porous structure of hydroxyapatite allows the cells to penetrate into the implants due to the growth of the cells into the pores. [6-7] In addition, the pores in the structure of hydroxyapatite act like a system of channels, and this structure allows blood and other important body fluids to reach the bone structure. Silicon carbide with properties such as high mechanical strength, high oxidation resistance and thermal shock resistance is used in many fields. Silicon carbide is a fairly hard, sharp and aggressive abrasive. Silicon carbide is a harder material than aluminum oxide. [8] Silicon carbide is a chemically more stable product, and because of its high resistance, it can be used for much longer period. Therefore in this study, it was investigated whether the strength of the newly formed material increases by combining the two materials compared to the non-mixed material described with the appropriate method. [9]

2. Materials and methods

As seen in Figure 1, 5 grams of hydroxyapatite powder was first measured and adjusted. It was then prepared to be homogeneously mixed by the 0,25 grams Si-C powder.

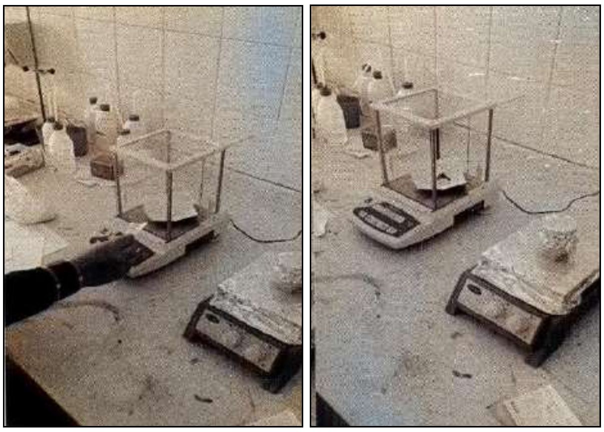

Fig 1: Weight measurement of hydroxyapatite powder and hydroxyapatite reinforced with Si-C mixture

As seen in Figure 2, the powders whose grams are adjusted were prepared to be mixed homogeneously.

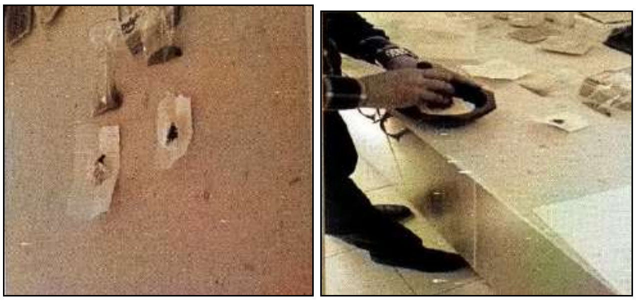

Fig 2: Mixing 0.25 grams Si-C and 25 grams of hydroxyapatite powders

As shown in Figure 3, PVC reinforced water is sprayed on the homogeneous mixture prepared in order to prevent the mixture from spreading.

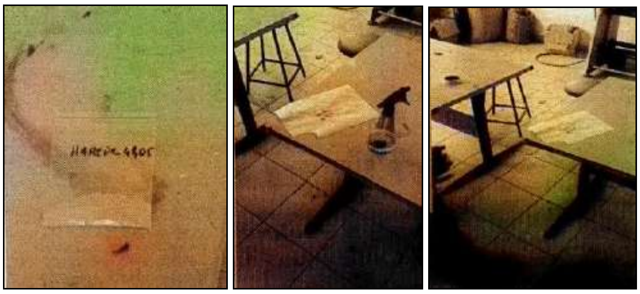

Fig 3: PVC reinforced water spraying to the prepared homogeneous mixture

Figure 4 shows the mold material, placing the prepared homogeneous mixture into this mold material, the machine to be used for pressing and placing the homogeneous mixture placed in the mold into the machine.

Fig 4: Mold material, pressing machine and placing the mixture placed in the mold in the machine for the process

After previous process the pressing process was started. This process continues up to approximately 5 tons. Figure 5 shows the final version of the samples after the pressing process. Silicon carbide and hydroxyapatite reinforced silicon carbide samples. The production purpose of these samples is to demonstrate the compressive strength difference between reinforced and unreinforced samples.

Fig 5: Samples formed after pressing

Compression tests were carried out with the machine shown in Figure 6.

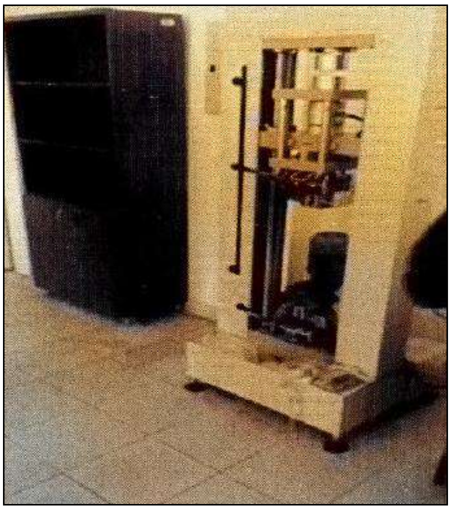

Fig 6: Compression test device

In Figure 7, compressive strength test was started by placing non-reinforced and reinforced samples.

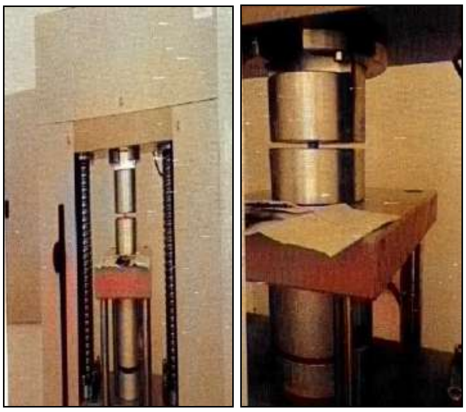

Fig 7: While the compression tests of the samples continue

3. Results and Discussion

Figure 8 shows the compression test result of the sample. According to these data, the strength of the silicon carbide reinforced hydroxyapatite sample with a diameter of 10.8 mm and a thickness of 4.3 mm has increased to 237 MPa. The strength of the non-reinforced hydroxyapatite sample with a diameter of 10.6 mm and a thickness of 4 mm was 96.9 MPa.

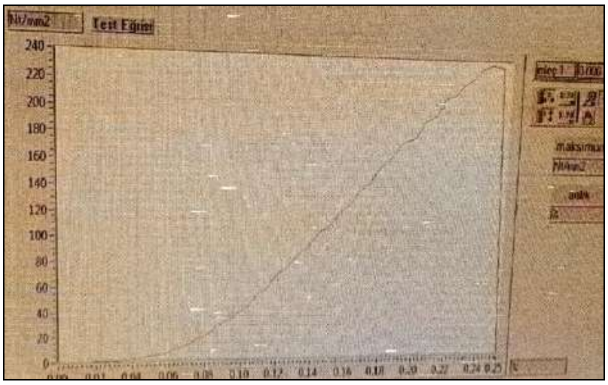

Fig 8: Compression test result

For new materials that can work in harmony with biological systems, research continues and biocompatible materials, whose importance and application area are increasing day by day, will develop in a way that will use or increase the body's self-renewal capacity.
Coating of metallic biomaterials with hydroxyapatite ensures reconstruction of natural tissues and contributes to increasing the duration of use of prostheses used in the body.

4. Conclusions

As a result, we can say that coating the metal surface with hydroxyapatite can be applied to all implants due to its price and easy production, as the thin and resistant bioactive layer does not change the surface morphology of the implant, including porous structures and screws. As a result of the tests, it has been shown that composite materials can increase the strength clearly. Composite materials can increase many more features, but studies in this research, It was about increasing the compressive strength of the composite material.

5. References

1. Billotte WG. Ceramic Biomaterials, the Biomedical Engineering Handbook: Second Edition. CRC Press LLC, 2000.
2. Tirrell M, Kokkoli E. The role of surface science in bioengineer materials, California, 2001.
3. Tas AC. Molten Salt Synthesis of Calcium Hydroxyapatite Whiskers. Jour. of Amer. Ceram. Soc. 2001; 84(2):295A300.
4. Wise DL. Biomaterials and Bioengineering Handbook, Camridge Scientific, inc. Belmont, Massachusetts, 2000.
5. Jordan DR, Mawn LA, Brownstein S, McEachren TM, Gilberg SM, Hill V, *et al*. The bioceramic orbital implant: a new generation of porous implants, Ophthal. Plast. Reconstr. Surg. 2000; 16(5):347A355.
6. White JA, Case KE, Pratt DB. Principles of Engineering Economics Analysis, 5th edition, Wiley, Hoboken, NJ, 2009.
7. Park CS. Fundamentals of Engineering Economics, 2nd edition, Prentice Hall, Upper Saddle River, NJ, 2008.
8. Newman DG, Eschenbach TG, Lavelle JP. Engineering Economic Analysis, 10th edition, Oxford University Press, New York, 2008.
9. Sanden B, Olerud C, Petren A, Mallmin M, Larsson S. Hydroxtapatite coating improves fixation of pedicle screws. The jour. of bone & joint surgery (Br). 2002; 84AB:387A391.