Review on Wear Testing on Metallic Bioimplants

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Abstract

The wear property is the deciding factor for bioimplants performance in longevity. The released of metallic ions or debris due to wear will cause adverse response in human body. Hence, it is of great importance to increase the wear resistance of implant material. The various methods adopted to check the wear rate are also discussed. The discharge of metallic ions is happen because of destruction or deterioration of passive film on the surface of the metallic materials. The various types of coating techniques are adopted to control the wear of the bioimplants.

Keywords: Wear resistance, bioimplants, and biomaterials.

Introduction

In the field of material science, the importance of biomaterial made bio-implants to mankind is outstanding. The bioimplants are those devices which are accepted by human beings to fix or replace a bone and to support its healing process. As it helps the individuals that even at the hour of birth are brought into the world with certain diseases and furthermore the matured population who want bioimplants so that they can live quality of life. Aside from the matured population, sports individual also requires replacements due to excessive strains on particular tissue or because of fracture.

The research on biomaterials is not new; it can be seen from many years back the Romans and Egyptians. They used different materials without considering their corrosion effects like gold or iron, sometimes wood for replacement of toe. At present when science commodity advances the new materials have been inverted which are utilized in dentistry, plastic and reconstructive medical procedure, orthopedics, neurosurgery, and so on. Materials, for example, metals and their alloys, polymers, ceramics and composites are generally used to manufacture the bioimplants. The diverse organic conditions i.e., distinctive physico-substance nature is experienced by these implants. Earlier scientific knowledge is lacking in this field and credit for the start and progression of present bioimplants are because of Harold Ridley, Paul Winchell, Per-Ingvar Branemark and others.

Surface oxide film which framed on metallic inserts assumes a significant role of inhibitor for the discharge of metallic particles. Be that as it may, the conduct of surface oxide changes with the release of particles.

Additionally, since reaction between the surfaces of metallic materials and internal body environment makes changes in the composition of the surface oxide. Many factors are responsible for increasing the discharge rate

of metallic ions like low concentration of dissolved oxygen, inorganic ions, proteins and cells. Once this surface oxide film is removed, the regeneration time of the film decides the amount of ions released.

Literature Review

Hanawa et al done research on metallic biomaterials used in biomedical fields. The focus of its research is mainly on the titanium metal maturation of surface oxide film, destruction and regeneration in vivo environment. The study also suggests improvement to be done on surface of titanium material to reduce the wear rate by calcium ion implantation for better bone conductivity [1].

Chen et al done study on various metallic biomaterials used in constructive surgery. The study focus on toxicity of discharge metal ions due to wear and corrosion. The study also suggests some promising techniques and strategies to deal with critical challenges [2].

Wear of Metallic Biomaterials

From the literature review, it is clear that wear resistance of metallic biomaterials plays an important role in the efficient working of implant inside the human body. Different examinations done for inspecting the wear property of the created bio medical materials. The different wear test arrangement plan which has been used by different analysts to portray the wear.

Wear Testing Methods

The characterize wear of created biomaterials by using desired test procedure is critical. Commonly used procedure to examine the wear property of metal bio medical materials are block on disc [3, 4], ball on disc [5-8] and pin-on disc [9] as shown in fig.1. Test performed under normal body temperature of 37^0C [4, 5] or surrounding conditions [3]. These tests are operating in simulated body fluid (Ringer solution) [3] to simulate real conditions. But in some studies the tests are conducted in dry state also [6, 7].

In pin-on-disk method, material to be tested is made of pin shape and is press against revolving grinding wheel. The advantage of the process is constant surface pressure. The set up closely resemble the linear friction bearing gives result in form of loss of material. So difficultly occur is aligning the pin, if the pin do not stand vertically to revolving disk corner of the pin contact. The touching side of pin removes the lubricant. In ball-on-disk, specimen is

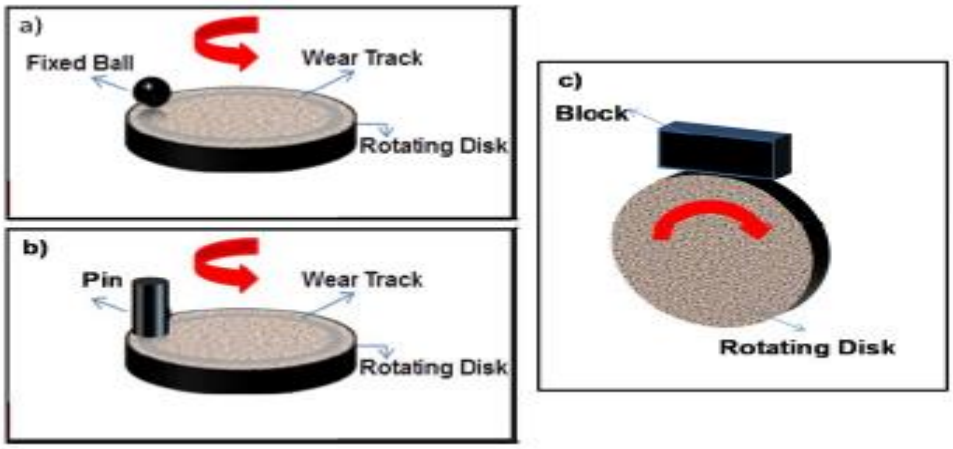

Fig. no.1 Schematic arrangement of (a) ball shape specimen on disk, (b) pin shape specimen on disk, (c) block shape specimen on disk wear test configurations.

made in the ball shape high pressure are conceivable. Ball specimen removes coolant during the test lower than that in pin specimen. Set up very much like radial friction bearing. The contact surface of the ball is less than the pin as compared to the revolving disk. The contact area is enlarged by wear. The disadvantage of this method is difficult to measure the wear volume of the ball specimen. In block-on-disk, specimen is made of block shape. The advantage of this method are fit for reproducing an assortment of brutal field conditions like heat, fast and high stacking pressure.

Wear Resistance of Biomaterials Improvement techniques

Wear resistance of metallic biomaterials can be improving by alloying or by various coating techniques. As seen in Ti alloys Nb is added to enhance the wear resistance but side by side hardness also increase. To relieve the hardness the heat treatment is done which again enhance the wear resistance. In Co Cr alloys made from forged technique observed more wear resistance than made by casting technique. Furthermore, Ni free Co Cr alloys shows improved wear resistance than compare with CoCrNi alloys. Various coating techniques like plasma spray coating, sol gel are used to enhance wear resistance. Surface treatment like nitriding, carburization is also used to improves the wear resistance.

Conclusion

The wear rate of biomaterial is the deciding factor for using any biomaterial for bio-implant manufacturing. The various test techniques are used to measure wear rate are discussed. The various techniques used to improve the wear resistance are also suggested.

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