Investigations of Different Coating Techniques & Microstructure Analysis on SS316L used as Orthopaedic Implant Material

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Abstract- *This research paper constitutes the study of coating tests and scanning electron microscope (SEM) images for a fractured surface for SS316L material (readily available) used for orthopedic implant. In medical field SS316L material has been used as a medical implant due to its high strength and its mechanical properties. In this coating for SS316L material is done by use of plasma spray technique and HVOF (High velocity oxygen fuel process) technique has been used and further Scanning electron microscope (SEM) images are taken out to see the structure of SS316L material to get the internal characteristics of the material. Generally coating is done to avoid corrosion so that this material can be used as an implant material in medical field.*

Keywords- Plasma spray coating, HVOF, SEM, SS316L

I. INTRODUCTION

Generally SS316L material is a readily available material with low cost. In this project work existing material SS316L selected for testing for coating and taking SEM images of it. SEM images are carried out to check the internal characteristics of SS316L material and to know the microstructure of SS316L material to know their bond strength in it. The same goes for coating process with different techniques is used know the bond strength of the material by using different powder particles, like ceramic and stellate.

LITERATURE SUREVY

[1]The conventional high-velocity oxy-fuel (HVOF) process has characteristics of high flame velocity and moderatetemperature, and is widely used to deposit cements, metals and alloys coatings such as WC-Co, nickel andstainless steel.[2]A critical discussion on the future of this technology is provided at the final part of the paper focusing on the microstructuralbonding mechanisms for those relatively less explored material systems.[3]Therefore, this paper provides a simple overview about the corrosion issue of stainless steel (SS) 316L as implants in human body. Electrophoretic deposition (EPD) of hydroxyapatite (HA) bio ceramic was proposed as the approach to minimize the corrosion phenomena. [4]Unfortunately in the present time, it has been found that the current used orthopedics implants have the tendencies to fail after long period of usage, due to the corrosion issue of implant in the human body. Therefore, this paper provides a simple overview about the corrosion issue of stainless steel (SS) 316L as implants in human body.

II. EXPERMENTIAL DETAILS:

2.1 COATING TEST FOR SS316L MATERIAL:

In medical industries, devices are used both internally and externally, so biocompatibility is critical. For improving bone conductivity and their bioactivity, coating is done with ceramics like hydroxyapatite, or coating with different ceramic powders. Also human body contains ions which can cause corrosion after implantation of materials in human body. To avoid this or to reduce this coating is done in order to provide free corrode and also with better life.

For coating SS316L material we have opted two types of coating they are:

- Plasma spray coating using zirconium (Zr) oxide ceramic powder.
- HVOF (High velocity oxygen fuel spraying) hydrogen coating using stellate.

2.2 EXPERMENTIAL PROCEDURE:

2.2.1 PLASMASPRAY COATING:

Initially the metal is cleaned thoroughly using CTC solution.

- Then Blasting is done (Silicon Blasting) of 20-25µ thickness.
- Air pressure blasting is done.
- Bond coating using Ni or alloy for binding is done.
- At last Zr coating is done.
- Material used for coating = ceramic oxide

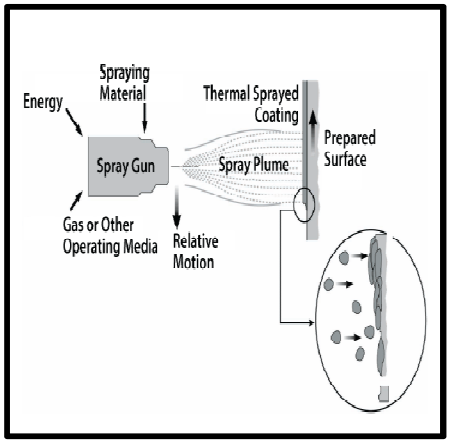


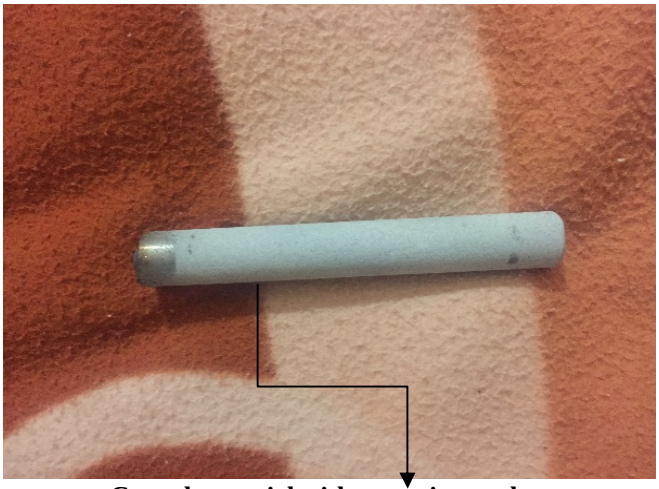
Fig1: Plasma Coating

SS316L MATERIAL BEFORE PLASMA COATING:

Uncoated SS316L material

Fig1.2: SS316L before coating

SS316L MATERIAL AFTER PLASMA COATING



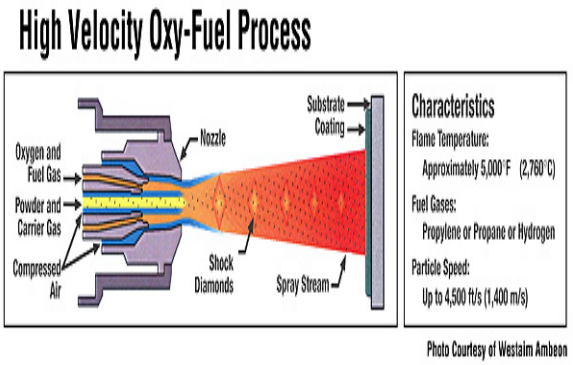
Coated material with ceramic powder

Fig1.3: SS316L after coating

2.3 EXPERMENTIAL PROCEDURE

2.3.1 HVOF COATING

- Initially the metal is cleaned thoroughly using CTC solution.
- Then masking (covering) is done.
- Air pressure blasting is done.
- Prescribed coating is done.
- Material used for coating = ceramic oxide



SS316L MATERIAL HVOF BEFORE COATING

Uncoated material

Fig: 1.4.: SS316L before coating

SS316L material after HVOF coating

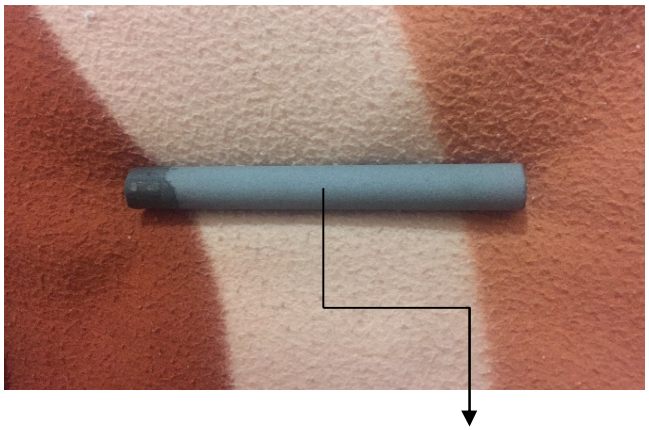


Fig1.5.:SS316L after coating

III. EXPERMENTIAL DETAILS: SEM IMAGES

- As the polymer material is non-conductive material directly taking out SEM images gives blur images, and getting accurate images is difficult. So to avoid this gold coating is done on the polymer material so that flow of electron on polymer material is perfect.
- After gold coating is done, dimensions of polymer material is checked so as to enter the values of length and breadth in the SEM software.
- The required surface of polymer material is polished through emery paper so that surface is lined.
- Once the above process is done the polymer material is kept inside the SEM setup as shown in fig.

[6]The morphologies and topographies of the two different type of stainless steel (304 L and 316 L) have been studied with using Scanning Electron Microscopy (SEM) and X-ray diffraction (XRD) techniques. The main aim is the [7]Nano structural evolution of these samplesthe HRTEM microstructure, selected area electron diffraction pattern (SAED) and lattice spacing of 10h milled duplex stainless steel powder sample. From above literature surveys we suggest SEM analysis to know the depth of material and to know the microstructure of the material so that its bonding properties are known.

SEM images of SS316L material

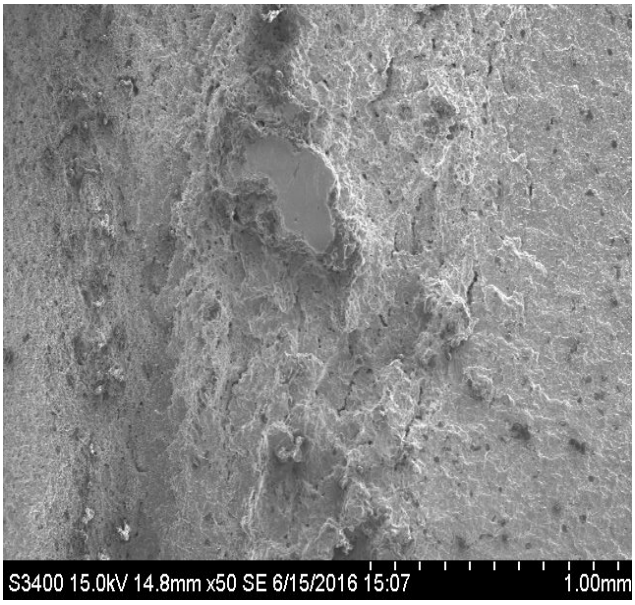


Fig1.6: SEM image of Magnification-50X

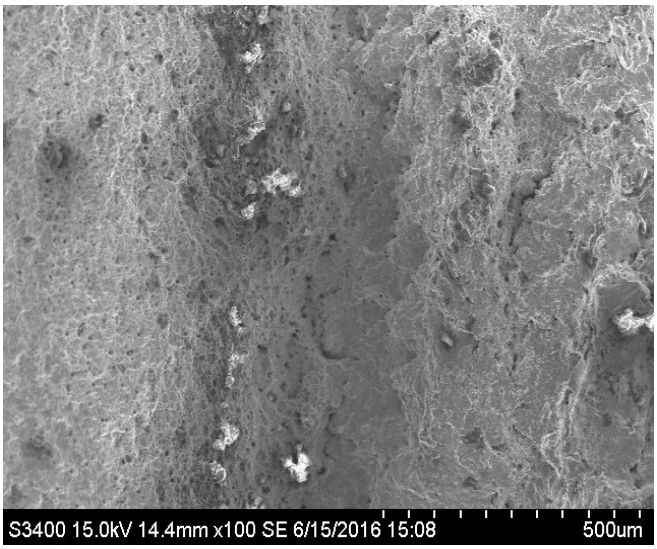


Fig1.7: SEM image of Magnification-100X

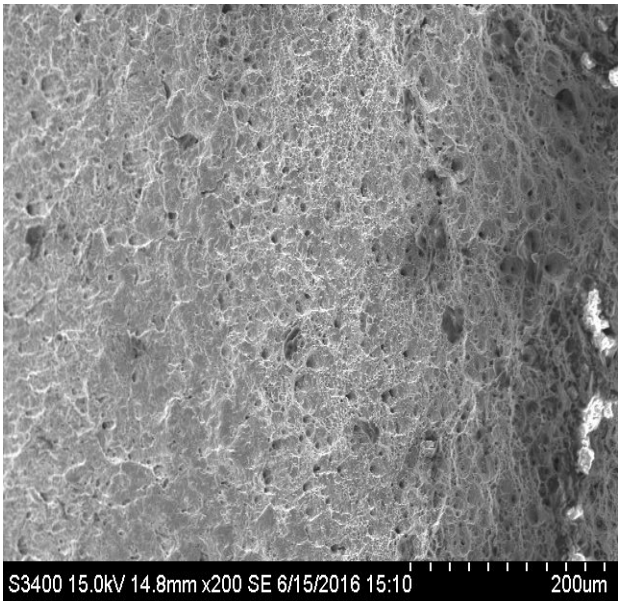


Fig1.8: SEM image of Magnification-200X

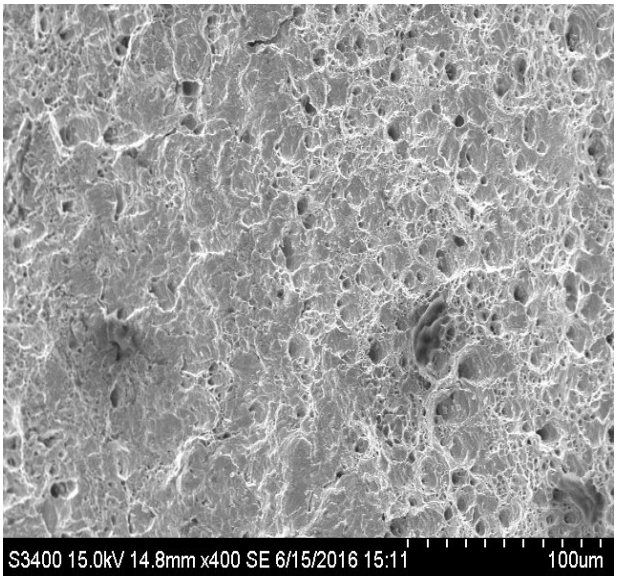


Fig1.9: SEM image of Magnification-400X

IV. CONCLUSION

We have carried out coating tests on SS316L material and it is found that the bonding between the powder particles of ceramic and stellate, these two powder particles are bio-compatible so that by using these powder particle we have coated SS316L material by using plasma spray technique and HVOF (HIGH VELOCITY OXY-FUEL PROCESS) technique. From these two techniques we found that plasma spray technique is good and economical, when compared to the other techniques. And we can get strong bonding between the powder particle and SS316L material. And from the above SEM images we found that the internal characteristics of SS316L material after fatigue test, at different magnifications (50X, 100X, 200X, 400X) and it shows that internal microstructure or properties of SS316L material has a greater bonding strength. Which can be further used in medical field as an implant.

REFERENCES

[1] Study on stainless steel 316L coatings sprayed by high pressure HVOF by B. Sun and H. Fukanuma, Saitama/J.

[2] Cold spray coating: review of material systems and future perspectives by A. Moridi, S. M. Hassani-Gangaraj, M. Guagliano and M. Dao. 2014 Institute of Materials, Minerals and Mining Published by Maney on behalf of the Institute Received 31 July 2013

[3] Feng, B., Chen, J.Y. and Zhang, X.D. (2001) Calcium phosphate coating on titanium induced by phosphating. Key Engineering Materials, 192-195, 167-170. doi:10.4028/www.scientific.net/KEM.192-195.167

[4] Gao, W., Liu, Z. and Li, Z., (2001) Nano- and microcrystal coatings and their high-temperature applications. Advanced Materials (Weinheim, Germany), 13, 1001-1004.doi:10.1002/1521-4095(200107)13:12/13 <1001::AID-ADMA1001>3.0.CO;2-V

[5] Sivakumar, M., Mudali, U.K. and Rajeswari, S. (1993) Pit-induced corrosion failures in stainless steel orthopedic implant devices. Proceeding of 12th International Corrosion Congress, Houston, 1949-1956.

[6] Nano structural properties of stainless steelfor Ultra high vacuum chambers by M.Pashaeiyan1 and A.Bahari2*

[7] SEM image of the stainless steel gauzes coated with porous polycarbonate film with the breath-figures self-assembly.From: Electrically Controlled Membranes Exploiting Cassie-Wenzel Wetting Transitions Membranes Exploiting Cassie-Wenzel Wetting Transitions