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STUDY OF CAVITATION EROSION AND CORROSION BEHAVIOR OF Zn COATING ON Cr-Ni-Mo STAINLESS STEEL BY ELECTRON BEAM METHOD

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ABSTRACT

The Zinc (Zn) powder was protected on the surface of Cr-Ni-Mo stainless steel and then made into an alloying layer by using the electron beam technique. Phases in the layers were investigated by X-ray diffraction (XRD) and surface morphologies after cavitation erosion were observed with the help of scanning electron microscopy (SEM).In this coating process acetone is used to clean the machined stainless steel material. There is no need of artificial cooling process after completion of electron beam coating method. The hardness of Cr-Ni-Mo stainless steel is tested with Zinc coating and without Zinc coating stainless was observed in Brinell hardness equipment. The layer has dense micro-structure, metallurgical bonded to the substance, and any cracks have been found. The layer had better cavitation resistance properties because of its metallurgical combination and the strengthening effects of the precipitate phases. Zinc gives some additional strength to the stainless steel and then the life span is increased after the electron beam coating. The coating has harder than the un-coated stainless steel because of the zinc coating. The coating layer has the thickness of four micron on the stainless steel.

I. INTRODUCTION

Corrosion is a natural process, which converts a refined metal to a more chemically stable form, such as its oxide, hydroxide or sulphide. It is gradual destruction of material by reaction with their environment. Erosion is the act in which earth is worn away, often by water, wind or ice.

Cavitation is the Process of formation of the vapor phase of a liquid when it is subjected to reduced pressures at constant ambient temperature. Cavitation erosion is the process of surface deterioration and surface material loss due to the generation of vapor or gas pockets inside the flow of liquid. Cavitation corrosion is particular form of erosion caused by the implosion of gas bubbles on a metal surface. It is often associated with sudden variations in pressure related to the hydrodynamic parameters of the fluid.

Physical vapour deposition is a collective set of processes used to deposit thin layers of material, typically in the range of few nanometers to several micrometers. Chemical vapour deposition is a process used to produce high quality, high performance and solid materials. The process is often used in the semiconductor industry to produce thin films.

Electron beam is the function of free electrons in a vaccum can be manipulated by electric and magnetic fields to form a fine beam. Where the beam is collides with solid state matter, electrons are converted into heat or kinetic energy. This concentration of energy in a small volume of matter can precisely control electronically, which brings many advantages.

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A scanning electron microscope is a type of electron microscope that produces images of a sample by scanning it with a focused beam of electrons.

The most common SEM mode is detection of secondary electrons emitted by atoms excited by the electron beam. By scanning the sample and collecting the secondary electrons that are emitted by using special detector. X-Ray diffraction is a rapid analytical technique primarily used for phase identification of a crystalline material and can provide information on unit cell dimensions. The analyzed material is finely ground, homogenized and average bulk composition is determined.

EXPERIMENTAL PROCEDURE

Type 316 stainless steel was machined for required dimensions, the material is reduced that from 85mm×12mm to 55mm×10mm. Zinc powder pelleted by hydraulic press to make the size of 20mm diameter and 10mm thickness. Before the coating process the material was cleaned in Acetone. Zinc coating layer by attained by Electron Beam physical vapour deposition. Completion of the coating process there is no additional cooling is required. Atmospheric cooling is more enough for the electron beam method.

Fig1. Electron beam PVD

After the coating process the following analysis and testing methods are done. Cavitation erosion behavior observed with Scanning electron microscope. In the SEM analysis the specimen was analyzed in different magnifications.

Fig2.316 Stainless steel before and after coating process

And the phases investigated by the X-ray diffraction method to synthesis the material and its coating. In the scanning electron microscope the material was Hardness of the stainless steel is tested and compared in Zinc coated stainless steel and non-coated stainless steel.

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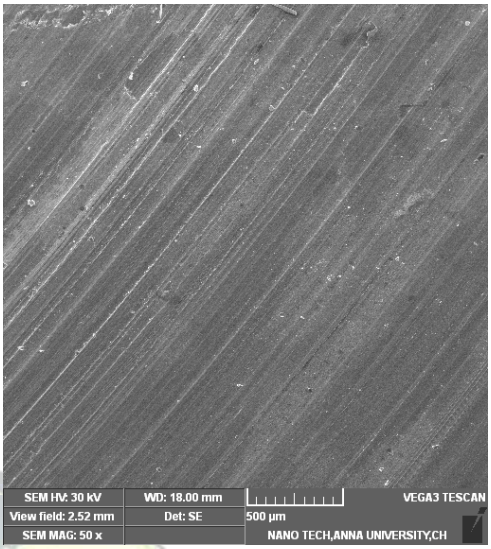

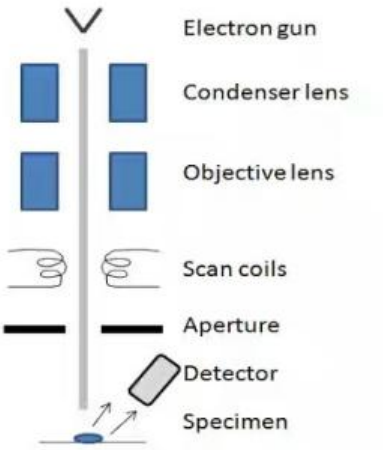

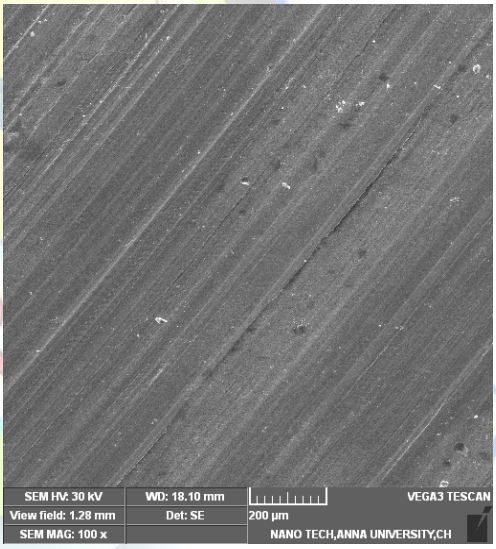

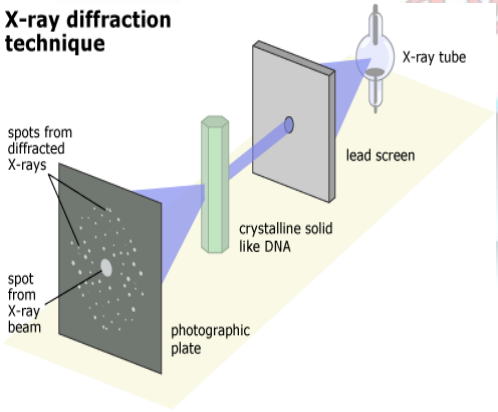

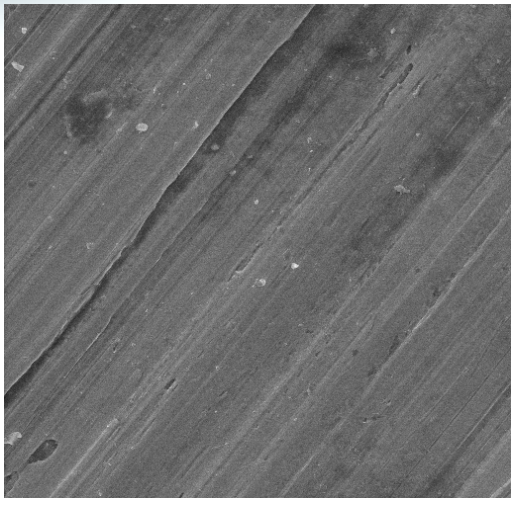

Fig3. Scanning Electron Microscope *Fig4. X-Ray Diffraction*

The different magnifications of SEM analysis are as follows. It shows that the coating and the material property. It gives the behavior of the 316 stainless steel after Zinc coating.

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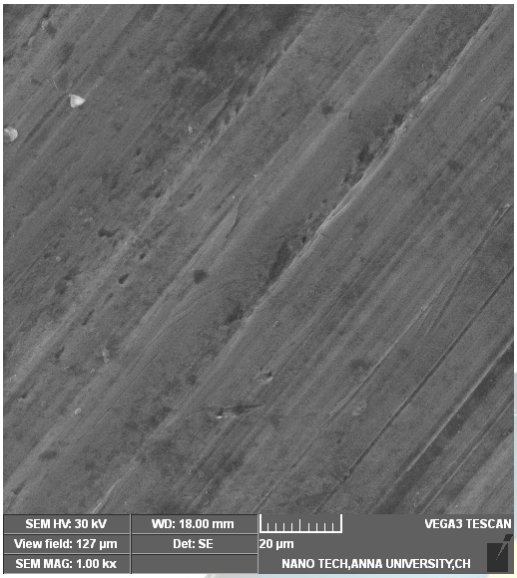

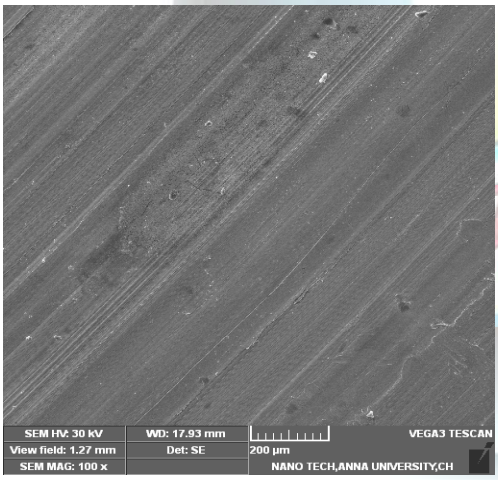

Fig5. SEM Analysis Images

CONCLUSION

In this project we use the zinc as the coating material and the base material of 316 stainless steel. Zinc is one of the hardness materials to give some additional strength to the stainless steel. The zinc layer was successfully observed by scanning electron microscope. Furthermore, it had better cavitation erosion and corrosion damage morphologies than Cr-Ni-Mo stainless steel.

In future we will analyze various base materials and comparison with different types of coating and coating method to find the best one in upcoming experimental analysis in the metallurgical properties of the various steels.

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