UNIVERSITI TEKNOLOGI MARA

EFFECT OF SURFACE ATTRITION ON THE MICROSTRUCTURE AND WEAR PROPERTIES OF BORONIZED GRADE 304 STAINLESS STEEL

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ABSTRACT

Grade 304 stainless steel has an excellent strength to weight ratio and high corrosion resistance; unfortunately it possesses very poor wear resistance. The structure of this type of stainless steel is austenitic and cannot be heat treated. This study focused on the effect of surface attrition using the shot blasting method on the surface of boronized grade 304 stainless steel. Boronizing was conducted at temperatures of 850˚C and 950˚C under two types of mediums which were powder and paste for the duration of 8 hours holding time. Boronized samples with thicker boride layer and superior wear properties were thus selected to undergo surface attrition using shot blasting method. The microstructure analysis and boride layer thickness were observed using optical microscopy, scanning electron microscopy (SEM) analyzer and energy dispersive X-Ray (EDX) spectrometry. Other tests such as pin on disc, erosion, microhardness, surface roughness and density were also conducted. Application of surface attrition on the surface of Pa-SB850 sample resulted in the formation of thicker boride layer with the thickness of 120 µm, an improvement of almost three times as compared to Pa-B850 sample with thickness of 43 µm. The microhardness result indicated the enhancement of approximately six times to the value of 1800 Hv compared to as received grade 304 stainless steel samples with the value of 261 Hv. The wear resistance of Pa-SB850 sample improved more than twice in term of COF value of 0.353 as compared to the SS sample with the COF value of 0.856. The erosion wear of Pa-B850 also improved two times compared to Pa-B850 sample with weight loss of 0.0512 g and 0.0911 g respectively at 16 hours erosion time. The implementation of surface attrition treatment resulted in grain refinements that allowed deeper boride layer to be diffuse into the surface of as received grade 304 stainless steel. The developed method makes it possible to implement boronizing in stainless steel which leads to improvement of properties such as hardness and wear resistance.

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CHAPTER ONE
INTRODUCTION

1.1 INTRODUCTION

Boronizing is one of thermo-chemical heat treatment process where boron is diffused on the surfaces of steel and iron. This treatment results in the formation of iron boride that contain FeB and Fe_2B phases, which help protect the surface by forming hard layers onto the surface of the material. The protected layers facilitate the wear resistance improvement of metallic materials, including iron and steels. The enhancement of wear properties is very much affected by the thickness of boronized layers, in which dependent on the boronizing medium, temperature and also time (Tavakoli et.al., 2015; Ozbek et.al., 2013; Moa et.al., 2012 and Gunes et.al., 2011). Thus, it is important that these parameters are explored to obtain superior wear properties of metal and alloy. The enhancement of the wear and hardness properties was usually obtained when the boride layer thickness was more than 100μm (Kulka et.al., 2016 and Yilmaz et.al., 2013).

The occurrence of wear in metallic materials is inevitably unavoidable as these materials are commonly used in applications that are constantly exposed to loading and frictions. Grade 304 stainless steel exhibits an excellent strength to weight ratio and corrosion resistance, but it has very poor wear resistance. As austenitic structures are not amicable to heat treatments, there are no phase changes upon cooling. Thus, no heat treatment could be conducted on the surface of austenite. The presence of chromium of 10 to 20 wt. % and other alloying elements such as nickel, molybdenum and vanadium also prevents the implementation of surface treatment onto the surface of the materials. Thus, it is almost impossible to boronize grade 304 stainless steel as in low alloy steel and plain carbon steel, which is the main reason of their poor wear resistance properties.

As boronizing was found to be one of the solutions to enhance of hardness and wear resistance, boronizing was conducted on grade 304 stainless steel in this study. In order to increase the thickness of diffusion layer, surface attrition treatment was conducted onto the surface of grade 304 stainless steel before applying boronizing