The Influence of Plasma Nitrocarburizing Process Temperature to Commercially Pure Titanium Surface Hardness

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Abstract. Commercially pure (cp) titanium is a relative soft metal and easily broken on friction-wear applications. To improve the hardness of the surface while maintaining the original properties, plasma nitrocarburizing process has been conducted. The effects of the treatment in different temperatures to the surface harness are then studied. In this study, cp titanium plasma nitrocarburizing process is conducted at different temperatures with different process time, i.e. at 350 °C for 3, 4, and 5 hours, and at 450 °C for 2, 3, and 4 hours respectively. Hardness tests are then performed on each specimen by using Micro Vickers Hardness Tester. The hardness values for the plasma specimens nitrocarburizing processes at temperature of 350 °C for process duration of 3 hours, 4 hours, and 5 hours are 74.16 HV, 92.25 HV and 94.41 HV, respectively, while for processes at temperature of 450 °C, the hardness values are 103.70 HV, 121.31 HV, and 126.17 HV for process duration of 2 hours, 3 hours, and 4 hours respectively. Hardness value of specimens which are resulted from the plasma nitrocarburizing process at temperature of 450 °C is higher compared with specimens that are processed at temperature of 350 °C.

Introduction

Titanium has outstanding properties in term of high strength to weight ratio, exceptional resistance to corrosion, and excellent biocompatibility. These attractive properties make them developed rapidly since the pure metal first become commercially available about sixty years ago [1-3]. Nowadays, titanium is widely used in industry and medical field [4,7].

In industry, about 80% of its usage is in the field of aerospace, besides that, the use of a pretty significant also in the field of chemical and petrochemical [1,8].

In medical field, titanium is widely used because of its excellent biocompatibility and less corrosion. Its applications involve surgical implant and implants, such as hip ball and socket in hip joint replacement that can last up to 20 years [9]. Titanium is also used in several medical fields such as dental implant materials, bone fitting, replacement of the skull, and the retaining structure of the heart valves [10-12].

On the other hand, titanium alloys are characterised by, especially in sliding situations, poor tribological properties. So, when cp titanium is used as a part of which will experience friction with other parts such as that is in hip joint replacement, the improvement of the hardness value will be required [13]. However when the hardness is increased by a certain treatment to the whole part, there is a possibility the material will become brittle, which is not expected. Any excessive loading applied to the material will damage it easily.

Increasing the hardness at the surface without changing the ductility properties of materials on the inside of the material will increase the toughness properties of material without changing the ductility if the inner part. This process is referred to as surface hardening.