Chapter 4
Enhancement of Surface Integrity of Titanium Alloy with Copper by Means of Laser Metal Deposition Process

Mutiu F. Erinosho
University of Johannesburg, South Africa

Esther T. Akinlabi
University of Johannesburg, South Africa

Sisa Pityana
National Laser Centre, South Africa

ABSTRACT

The laser metal deposition process possesses the combination of metallic powder and laser beam respectively. However, these combinations create an adhesive bonding that permanently solidifies the laser-enhanced-deposited powders. Titanium alloys (Ti6Al4V) Grade 5 have been regarded as the most used alloys for the aerospace applications, due to their lightweight properties and marine application due to their excellent corrosion resistance. The improvements in the surface integrity of the alloy have been achieved successively with the addition of Cu through the use of Ytterbium laser system powered at maximum of 2000 Watts. The motivation for this research work can be attributed to the dilapidation of the surface of titanium alloy, when exposed to marine or sea water for a longer period of time. This chapter

DOI: 10.4018/978-1-5225-0329-3.ch004

provides the surface modification of titanium alloy with the addition of percentage range of Cu within its lattices; and the results obtained from the characterizations conducted on the laser deposited Ti6Al4V/Cu alloys have been improved.

1. INTRODUCTION

So many research works have been conducted on titanium and its alloys both presently and in the past. These works have facilitated the researchers to discover the best method on how to improve on the production of the alloys, in order to enhance their functionality in service. Ti6Al4V alloy is the most applicable among the titanium alloys; since it exhibits a combination of mechanical, physical and corrosion-resistance properties which have made it desirable in the aerospace, chemical industries, energy and automotive industrial services. These alloys are also applied in the developing biomedical applications, due to their excellent biocompatibility among metallic materials (Moiseyev, 2006; Lutjering & Williams, 2007).

The enhancements in the mechanical properties of titanium alloys have mostly been achieved through the addition of alloying compounds (Sen et al., 2010; Gogia et al., 1992; Okazaki et al., 1993; Tian & Nemoto, 1997).

The alloying additions in titanium can be divided into three different classes. The α-stabilizers - an example is Aluminium which impart solid solution strengthening to titanium; the neutral additions, such as tin and zirconium, also contribute to solid solution strengthening; and finally, the β-stabilizers, such as vanadium, molybdenum, niobium, iron, copper, chromium and manganese, serve to introduce the β-phase in an otherwise α-phase microstructure (Leyens & Peters, 2003).

A desired microstructure could also be obtained through thermo-mechanical processing, like the basket weave microstructure achieved from heat treatments in the β-phase field. This is found to offer better creep resistance than an equiaxed α/β phase microstructure (Mishra et al., 2005). The addition of copper to titanium alloys influences the mechanical properties through age- hardening (Lutjering & Weissman, 1970). A beneficial effect of precipitation strengthening has been utilized in Ti-2.5Cu (in weight percent (wt.%)) over commercially pure titanium (Donachie 2000). The work was later extended to titanium alloys containing a variety of other alloying additions with minor composition modification. An experiment was also conducted by substituting vanadium for copper with the same 4 wt.% of vanadium; and this yielded the same results. Copper (Cu), a β-stabilizer, exerts the same influence on the β transus temperature as vanadium; and the direction on the β transus of Ti6Al4V alloy was not affected (Bania et al., 1993). Consequently, an attempt was made by Gollapudi et al., (2011) to improve the compressive strength, as well as the hardness of titanium alloys, by utilizing the precipitation-hardening technique

The Effect of Molybdenum on the Alloy Properties of the CoCrNiFeMnNb System

Svetlana Kvon, Vitaliy Kulikov, Olegas ernašjusand Yevgeniy Skvortsov (2026). *International Journal of Surface Engineering and Interdisciplinary Materials Science (pp. 1-20).*

www.irma-international.org/article/the-effect-of-molybdenum-on-the-alloy-properties-of-the-cocrnifemnnb-system/404001