ADVANCES IN MATERIALS ENGINEERING

Volume 1

Edited By:
Zahurin Halim
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Table of Content

Chapter 008

Composite Coating on Titanium Alloy Using High Power Laser

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Keywords: CO_2 laser, Titanium, Silicon carbide, nitrogen, argon, dendrite, composite, hardness

Abstract. Results obtained on surface modification of titanium alloy by creating a surface layer metal ceramic composite using a high power laser beam are reviewed. In the laser metal ceramic composite layer formation process, the surface is melted and combined or embedded with hard ceramic particles to form a surface with a new chemistry. The new surface can have a composition quite different from the base metal. The properties of the treated surface are completely different from the matrix. This laser method can tailor the properties of titanium to suite the service requirements.

Introduction

Titanium and its alloys have good corrosion resistance and high specific strength but have poor wear resistance property which limits their use in many dynamic applications particularly in aerospace applications. The wear resistance of titanium can be enhanced through surface modification techniques which involve the creation of new surface chemistry in the material resulting either in alteration of chemical composition or phase transformation or the combination of both with better structural properties than the original substrate. There are several schemes of the surface modification techniques including plasma vapour deposition (PVD), chemical vapour deposition (CVD), ion sputtering, laser melting and a host of others. In all these techniques, the substrate material is melted over a specific surface area under a heat source; the resolidified structure produce microstructure of hard phases. Since the structural modification is restricted to the surface, the bulk properties of the material are not affected and this provides an attractive option for creating a wear resistance surface compared to the conventional bulk heat treatment or using costly superior quality product if only a small area needs with specific properties. In this paper one of the current 'high tech' methods for tailoring surface properties of components made of titanium to meet specific requirement is discussed. Laser Metal Ceramic Composite (MCC) layer formation process causes compositional transformation and phase transformation, and can be considered as surface modification.

Experimental Method

Many series of experiments were performed using a 5 kW CO_2 laser at AEA Culham Laboratory, Abingdon, England. The laser MCC layer formation was done by laser-glazing preplaced ceramic powder on commercial purity titanium (CPTi) substrate surfaces under both neutral and reactive environments. Preplaced SiC_p ceramic powders (5, 10 and 20 vol%) were laser-glazed at a constant beam power of 2.8 kW with scanning speeds of 5 mm/s and 10 mm/s in either neutral (argon or helium) or reactive (pure nitrogen, mixture of nitrogen-argon or mixture of nitrogen-helium) environments. The laser glazing conditions used for this work are given in Table 1. The morphological, microstructural and hardness characteristics of the produced MCC layers were evaluated via optical microscopy, scanning electron microscopy and microhardness measurement.