

Chapter 6

Laser Surface Processing for Tailoring of Properties by Optimization of Microstructure

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ABSTRACT

Laser surface processing involves modification of surface microstructure and/or composition of the near surface region of a component using a high power laser beam. The advantages of laser surface processing over conventional equilibrium surface processing include rapid processing rate, retention of non-equilibrium microstructure, alloying in liquid state and development of processed zone with superior properties as compared to the same developed by equilibrium processing route. Microstructure plays an important role to control the final properties of the tailored component. In the present contribution, with a brief introduction to laser, and its application, the microstructures developed under optimum conditions by different laser surface processing will be discussed with the corresponding improvement in properties. Finally, a brief review of the future scope of research in laser surface processing will be presented.

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1. INTRODUCTION

Laser, the acronym of Light Amplification for Stimulated Emission of Radiation (LASER), is a coherent source of light and energy (Steen, 2003). Due to the unique advantages of its ability to deliver a high power density within a very short interaction time, a rapid processing speed, environment friendliness and ability to deliver a clean processed zone it has wide range of application in materials science and materials processing (Steen, 2003; Dutta Majumdar & Manna, 2011). In the past, laser processing has successfully been applied to tailor the surface or bulk processing of component (Steen, 2003). The application of laser in bulk materials processing are machining, welding, direct laser metal deposition, and forming (Steen, 2003; Dutta Majumdar & Manna, 2011). On the other hand, application of laser in surface processing includes modification of microstructure and/or composition of the near surface region of a component using laser as a source of heat. In the past, laser surface processing has been successfully applied for improving wear, corrosion and oxidation resistance of magnesium and its alloys, titanium, steel and aluminium by laser surface melting, laser surface alloying, laser surface cladding, laser surface texturing and by pulsed laser deposition (Majumdar & Manna, 2011). In all the treatments, it has been observed that laser parameters play important role to ensure the formation of defect free surface with the desired microstructure for tailoring its properties (Steen, 2003; Majumdar & Manna, 2011; Dutta Majumdar & Manna, 2013; Molian and Sudarshan, 1989; Draper and Poate, 1985). In this regard, it is also relevant to mention that, microstructure controls the mechanical, chemical and thermal properties developed in the processed zone. Hence, the key to optimization of process parameters lies on engineering of the microstructures for the desired application.

In the present contribution, a detailed discussion on the microstructures developed in different laser surface processing and the ways to control it will be discussed in details. The contribution has been divided into 5 sections; a brief introduction to lasers and its application, microstructures developed for different laser surface processing and associated improvement in properties will be discussed. Finally, a brief review of the future scope of research in laser surface processing will be presented.

1.1 Laser and its Application in Materials Processing

The unique characteristics of laser which distinguishes itself from the other source of light include (a) coherency, (b) monochromaticity and (c) directionality. The monochromatic radiation, refers to the radiation with single wavelength (Steen, 2003; Dutta Majumdar and Manna, 2011). Laser beam irradiates light within a very narrow band of wavelengths. Due to its monochromaticity, laser beam may

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