Chapter 8
Computational Dynamics of Laser Alloyed Metallic Materials for Improved Corrosion Performance: Computational Dynamics of Laser Alloyed Metallic Materials

Olawale Samuel Fatoba
Tshwane University of Technology, South Africa

Gabriel Ayokunle Farotade
Tshwane University of Technology, South Africa

Abimbola Patricia Idowu Popoola
Tshwane University of Technology, South Africa

Sisa Lesley Pityana
National Laser Centre, South Africa

ABSTRACT

Laser alloying is a material processing method which utilizes the high power density available from defocused laser beam to melt both metal coatings and a part of the underlying substrate. Since melting occur solitary at the surface, large temperature gradients exist across the boundary between the melted surface region and underlying solid substrate, which results in rapid self-quenching and re-solidifications. Alloyed powders are deposited in a molten pool of the substrate material to improve the corrosion resistance of the substrate by producing corrosion resistant coatings. A 3D mathematical model is developed to obtain insights on the behaviour of laser melted pools subjected to various process parameters. Simulation with 3D model with different values of various significant processing parameters such as laser

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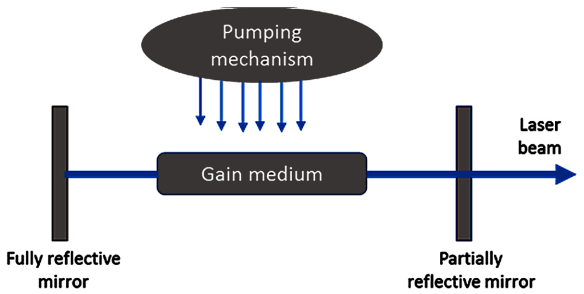
power, scanning speed and powder feed rate influences the geometry and dynamics of the melt pool, and cooling rates. It is expected that the melt pool flow, thermal and solidification characteristics will have a profound effect on the microstructure of the solidified region.

1. INTRODUCTION

1.1. Laser Phenomenon

The word laser is an acronym that stands for Light Amplification by Stimulated Emission of Radiation. As said in the definition, laser is light but different from the normal light that is used on daily basis in terms of the beams they possess. In laser, the laser beam is much narrower than flash light with only one colour while the normal light is wide with many different colours (Toma, 2005). Majumdar and Manna (2003) refer to a laser as a device that consists of three basic components; an optical system, active medium and pumping source. An optical system or cavity is also referred to as feedback mechanism consisting of two mirrors placed parallel to each other forming an optical oscillator. The active medium which can be atoms, molecules or ions in gaseous state or solid crystal is placed between the mirrors and the chemical species in the gain medium; it determines the wavelength of the input through the process of stimulated emission. The pumping source supplies energy to the gain medium by exciting the laser medium into higher quantum energy levels. When an external energy is supplied to the irradiated atoms, the atoms attain an excited state and spontaneously emit a photon. The photons moving along the optic axis interact with a large number of excited atoms, stimulate them and get amplified. The process occurs repeatedly creating more photons which exit through the partially transmitting mirror as intense laser beam as indicated in Figure 1 Eventually the laser beam is guided to the work piece by the reflective mirrors or optical fibres.

Figure 1. Schematic diagram illustrating the basic principle of lasers (Majumdar & Manna, 2003)



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