Chapter 6
Application of Laser Assisted Cold Spraying Process for Materials Deposition

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ABSTRACT

The Laser-Assisted Cold Spraying (LACS) process is a hybrid technique that uses laser and cold spray mechanism to deposit solid powders on metal substrates. For bonding to occur, the particle velocities must be supersonic. The supersonic effects can be achieved by passing a highly compressed Nitrogen gas (≈30 bars) through de Laval supersonic nozzle. LACS is a surface coating technique that is desirable in rapid prototyping and manufacturing, particularly for biomedical applications. Current world research reveals that the capability of the LACS regarding the enhancement of surface properties of coating titanium alloys with hydroxyapatite will

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be essential for fabricating scaffolds for bone implants using Laser Engineered Net Shaping (LENS) technique. In this chapter, coatings of composite powders made of titanium and hydroxyapatite deposited on Ti-6Al-4V substrate by LACS technology are presented. These coatings were successfully characterised by means of X-Ray Diffraction (XRD) and optical microscopy for their phases, composition, and microstructure, respectively. The results of the produced LACS coatings compare well with those obtained with traditional thermal spray and cold spray techniques, respectively. In addition, the XRD results were found to be similar to the precursor powders, which indicated that no phase transformation occurred to HAP. Coatings comprising of other crystalline phases of HAP are less bio-integrable and fail quicker within the human body fluids environments.

1. INTRODUCTION

Materials coating techniques are recommended for surface treatment to either effectively induce good mechanical properties and/or restore the quality of the surface of metals that have endured long service under harsh operating conditions. Most importantly, surface treatment is required since heavy costs are now related to surface wearing off due to stress, fatigue or mechanical failure. In some other cases, the costs of replacing the entire unit are exorbitant when compared to reengineering. A review on the economics of current manufacturing techniques such as laser powder deposition (LPD) is available in literature (Costa & Villa, 2009). Morrow, Qi, Kim, Mazumder, and Skerlos (2007) have detailed a discussion on the energy consumption, environmental and the economics of direct metal deposition technology. Gutowski, Dahmus, and Thiriez (2006) have detailed energy consumption per capital for manufacturing processes. The current technologies are not only cost effective, but according to Costa and Villa, they also present sound environmental impact assessment cases, which makes them even more attractive given the current laws around climate change and global warming. These aspects though necessary to discuss, are not addressed in this chapter. Likewise, thermal spraying technologies like high oxygen velocity fuel are characterised of heavy cost in processing since they require inert environment for processing and enclosed environment controlled oxidation. These aspects are discussed later in this chapter.

Surface engineering, particularly of metals, has gained momentum and significant recognition given its role in refurbishing worn metal parts, and effective bonding of metal to metal where necessary. In manufacturing in particular, surface treatment is largely required where replacements of the working part can be achieved only by incurring high cost. Fortunately, most functioning worn out metal machines can be amended at low cost and in short time by means of different treating techniques.
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