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3D FINITE ELEMENT ANALYSIS IN THE SELECTIVE LASER MELTING PROCESS

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Abstract
Selective Laser Melting (SLM) is actually the most attractive technique in an Additive Manufacturing (AM) technology because of the possibility to build layer by layer up nearly full density metallic components without needing for post-processing. One of the main problems in SLM processes is represented by the thermal distortion of the model during forming; the part tends to be deformed and cracked due to the thermal stress. Therefore, it is important to know the effect of the process parameters on the molten zone and consequently on the density of the consolidated material. Great advantage can be obtained from the prediction of temperature evolution and distribution.

The aim of this study is to evaluate the influence of the process parameters on the temperature evolution in a 3D model. The developed code evaluates the distribution and evolution of the temperatures in the SLM process and simulates the powder-liquid-solid change by means of a check of the nodes temperature.
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Key Words: Rapid Prototyping, Selective Laser Melting, FEM, Metal Powders

1. INTRODUCTION

Selective Laser Sintering (SLS) was developed by Carl Deckard at the University of Texas at Austin, USA in 1987 for making plastic prototypes. In 1992, DTM Corporation (Texas, USA) introduced the Sinterstation™ machine for SLS [1]. Later on it also became a common technology to produce products for long-term use. The success of SLS as rapid prototyping and rapid manufacturing technology mainly results from the ability to process almost any type of material.

Recently, the interest in SLS is mainly focused into metals because of the possibility of building metal parts of complex geometries that can be used not only for the prototyping step but also for a small series [2, 3]. This aspect is mainly attractive in aerospace, automotive, electronics and biomedical industries, as well as many others technological fields.

Driven by the need to process nearly full dense objects, with mechanical properties comparable to those of bulk materials and by the desire to avoid lengthy post processing cycles, SLM has been developed. Polymers as well as metals can be completely molten by a laser beam, however the appellation Selective Laser Melting is reserved for metallic materials. In SLM nearly full density parts can be produced without needing for post-processing steps, while the same materials can be used as in serial production. In order to reach a high density, the metallic powder particles are fully molten.

Basically, the SLM process is the same as SLS: the difference between them consists in the full melting of powders in the first one and in the partial melting in the second one. Thus, SLM involves higher laser energy densities than SLS. One of the serious problems in SLM processes using metallic powders is the thermal distortion of the model during forming [4].

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