PhD project

Additive Manufacturing of metallic parts: combination of Selective Laser Melting with Laser Shock Peening

Selective laser melting (SLM) is a part of a large family of Additive Manufacturing (AM) processes. Over the last decades more than thirty different types of Additive Manufacturing processes have been developed, SLM being one of the most researched over the past years. In the SLM process the part is built layer by layer out of a metallic, ceramic, polymer or composite powder. At each step, a powder bed is deposited on a substrate and selectively melted by a laser beam piloted by the CAM system. Using a laser beam deflection system, each layer is scanned according to its corresponding cross section as calculated from the CAD model. After solidification, the material is consolidated and a new powder layer is deposited. The operation sequence is repeated until the completion of the part. At the end, the unused powder is removed and recycled.

Although the mechanical properties of SLM metallic parts have become close to those of bulk material, SLM has some inherent drawbacks such as warping, cracking and detrimental tensile residual stresses. A large degree of shrinkage occurs during liquid - solid transformation, thus accumulating considerable tensile residual stresses on the surface of the SLM produced components. The complex residual stresses that arise during cooling are regarded as key factors responsible for the distortion and even delamination of the final parts. These residual stresses may also cause process failure during the building phase.

The objective of the PhD work is to develop further a hybrid SLM-LSP manufacturing system for metallic parts, in which the SLM process is complemented by periodic Laser Shock Peening (LSP) treatments, every few SLM layers. Pioneering work by the LMTM laboratory at EPFL [1,2] has already shown promising results concerning the 3D control of residual stresses with such an approach. Additional work is however needed in order to build an automated lab prototype, demonstrate the possibility to control 3D distortions and microstructures, and improve fatigue life.

The PhD work is expected to start early 2018.
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