In-situ process monitoring of Electron beam Powder Bed Fusion using near-infrared imaging

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Abstract: Electron beam Powder Bed Fusion (E-PBF) is an additive manufacturing process that allows metallic parts to be built by selectively melting successive layers of powder. However, this process can generate defects in the fabricated parts. To improve the reliability of this process, there is a need to develop in-situ monitoring imaging techniques. The main objective of this work is to set up strategies to characterize in-situ the E-PBF process. The selected tool is a near-infrared (NIR) camera employed to obtain images of the parts being manufactured. The first part of the work has been dedicated to setting up an experimental device allowing to acquire near-infrared images in an automated way and by taking into account the constrained environment of E-PBF (high temperature, vacuum, metal deposit on the walls). Two strategies of in-situ monitoring of E-PBF are suggested. The first one aims at taking one image per layer, just after the melting stage. Image analysis routines were developed and allow to identify and determine the spatial distribution of the defects (geometrical distortions, porosity) from their thermal signatures on the NIR-images. The detection of internal defects is validated with a non-destructive characterization (X-rays computed tomography). The second strategy consists of carrying out continuous image acquisition to analyze the temporal evolution of the grey level which is directly related to temperature changes. A methodology allowing to detect, even to anticipate given defects related to the energy delivered by the electron beam has been proposed. Those two approaches should allow the defects to be identified as quickly as possible to apply a correction within the framework of future closed-loop process control.