Melting of a powder bed: numerical and experimental approaches

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Selective Laser Melting is among the additive manufacturing processes most used. It is one of the Powder Bed Fusion AM processes that consists in producing fully functional metal parts presenting high mechanical properties. The large use of SLM process and the need to improve and better control this process ability have led to the development of several numerical simulation approaches, which may provide valuable assistance to study the process's effects on the final parts. These fluid flows are related to the strong thermal gradient and caused by the effects of surface tension "Marangoni and curvature effects". This dynamic in molten pool can affect the temperature field distribution, the morphology of the molten zone and the generated stress field. Therefore, in order to reproduce as possible the physical phenomena during the SLM process, it is very important to take into account the fluid flows during numerical simulation. Generally, a weak coupling is used to relate these computations. In this context, the aim of this work is to propose a new method to simulate the interaction between fluid flows and solid deformations. In first step, a new approach was developed, it consists to take into account the dynamic in molten pool through the two effects of surface tension (including both "curvature effect" and the "Marangoni effect") and buoyancy. Additionally, the free surface was considered using an ALE method. The shrinkage of the powder layer after melting, and the change of the thermal-physical properties depending on the material state (powder or compact) were also taken into account.

Although the study consisted mainly in developing numerical methods, it also includes an experimental part. Specific set-up was done using different instrumentation tools (high-speed camera, thermal camera, optical pyrometer…). These tools allow to better understand the physical phenomena involved during the melting of a powder bed.