Master’s Thesis

SPH Modeling of Selective Laser Melting of Ceramics for Additive Manufacturing Applications

Introduction

Additive Manufacturing (AM) processes are a group of modern technologies, where a new component is produced incrementally layer-by-layer. A popular AM technique for building complex 3D parts is Selective Laser Melting (SLM). In SLM of ceramics, a guided laser beam provides the energy required for melting a ceramic powder bed followed by a repetitive process of deposition. This process involves a multiplicity of extremely complex physical phenomena occurring at micro scales, making analytical approaches to explain the process nearly impossible. A simulation-based approach seems a viable alternative for deepening the process understanding, since experimental studies of the SLM process would be too costly and limited at best.

Challenges

In this project, a numerical framework is developed for the multiphysics modeling of the melt pool during SLM of ceramics. Smoothed Particle Hydrodynamics (SPH), as the most popular meshfree particle method, is employed due to its efficiency and unique capabilities in handling free-surfaces and multiple material-phase interfaces. The implementation needs to resolve thermal, mechanical, and material aspects of the SLM process including heat transfer, melting, phase change, viscous flow, and re-solidification of metallic materials.

Tasks

- Literature survey of Particle Methods applications in AM simulations
- Validation of the method in a few simple benchmarks (thermal, mechanical, material)
- Simulation of a complete SLM process with experimental/numerical verification

Requirements

- Interested in computational science (CFD knowledge is a plus) and additive manufacturing
- Strong mathematical & mechanical background
- C/C++ Programming

Layout

- 20% Theory & Analysis – 50 % Implementation – 20% Verification - 10% Documentation

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