Numerical Study of Edge Repair Using Laser-Directed Energy Deposition

Laser-directed energy deposition (L-DED), also known as laser cladding, is a metal additive manufacturing technique used to fabricate metallic components and repair damaged ones. In an L-DED process, metallic powder is delivered to a specified location on an existing component, where a laser beam melts the powder and a thin layer of the substrate. The molten material then solidifies to form a deposited track. Repeated tracks are built into layers, and layers are built up to create the required repair feature. With a four- or five-axis motion system, L-DED can deposit material on complex surfaces, making it attractive for repair and remanufacturing applications.

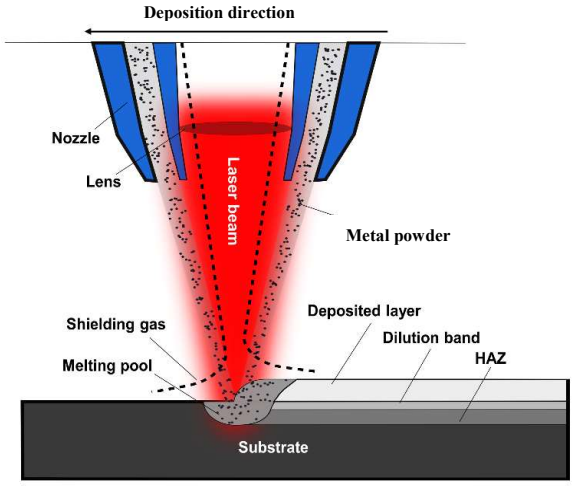

Fig. 1. Schematic of an L-DED process.

The quality of L-DED-repaired components is strongly influenced by residual stresses and distortion generated during the complex thermo-mechanical process. These responses depend on process parameters such as laser power, powder feed rate and scan speed, as well as post-processing treatments. For quality control, it is important to understand how these factors affect repair quality. Experimental trial-and-error approaches are expensive and time-consuming, whereas computational simulation can efficiently evaluate the effects of individual process parameters on the residual stress and distortion of repaired or remanufactured components.

Building on our current research on the numerical simulation of L-DED slot repair, this project will numerically investigate edge repair using laser-directed energy deposition. Simufact Welding will be used for the simulations. The main tasks are as follows:

1. Conduct a literature review of L-DED repair and related research.
2. Develop an L-DED edge repair model to predict residual stress and distortion.
3. Perform a parametric study to investigate the effects of key processing parameters.

Students undertaking this project should have a sound knowledge of thermodynamics and solid mechanics, as well as an interest in computational simulation.