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PROCEEDINGS

# Marangoni Convection Shifting, Heat Accumulation and Microstructure Evolution of Laser Directed Energy Deposition

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## ABSTRACT

Laser Directed Energy Deposition (LDED) technology was employed to fabricate internal structures within the hollow interiors of rotating parts, such as tubes and cylinders. A three-dimensional transient multiphysics model for C276 material was developed, which anticipated the impact of angular velocity from tube rotation on various aspects. This model, validated by experiments, focused on the melt pool morphology, Marangoni convection, oriented crystal microevolution, and deposited material microhardness. It was found that at 150 ms deposition, the dimensions of the melt pool stabilized. With an increase in the Peclet number, heat transfer within the melt pool transitioned from conduction to convection. A rise in angular velocity reduced the melt pool deposition height, limited by the volume of the deposited material. Additionally, this angular velocity generated tangential forces, leading to an asymmetric melt distribution in the longitudinal section of the melt pool and a movement of the melt toward the melting front. At the bottom of the melt pool, the growth of C276 columnar crystals was notably inclined towards the center of Marangoni convection. The microhardness of the deposited material showed a stable distribution along the inclined crystal direction, whereas significant fluctuations were observed perpendicular to the cylinder substrate. These findings highlighted the considerable effect of Marangoni convection on the microstructural evolution.

## KEYWORDS

Numerical simulation; thermal and velocity fields; marangoni flow shifting behavior; microstructure orientation

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