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Impact of Hatching Strategies on Overhang Displacement in PBF-LB/M

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Strategies to Reduce Overhang Displacement

Incorporate layer rotation

Maximize hatch length

Prioritize scanning towards the overhang

Avoid orthogonal hatching relative to overhang edges

Implement a minimum 4 mm overhang-specific hatch zone

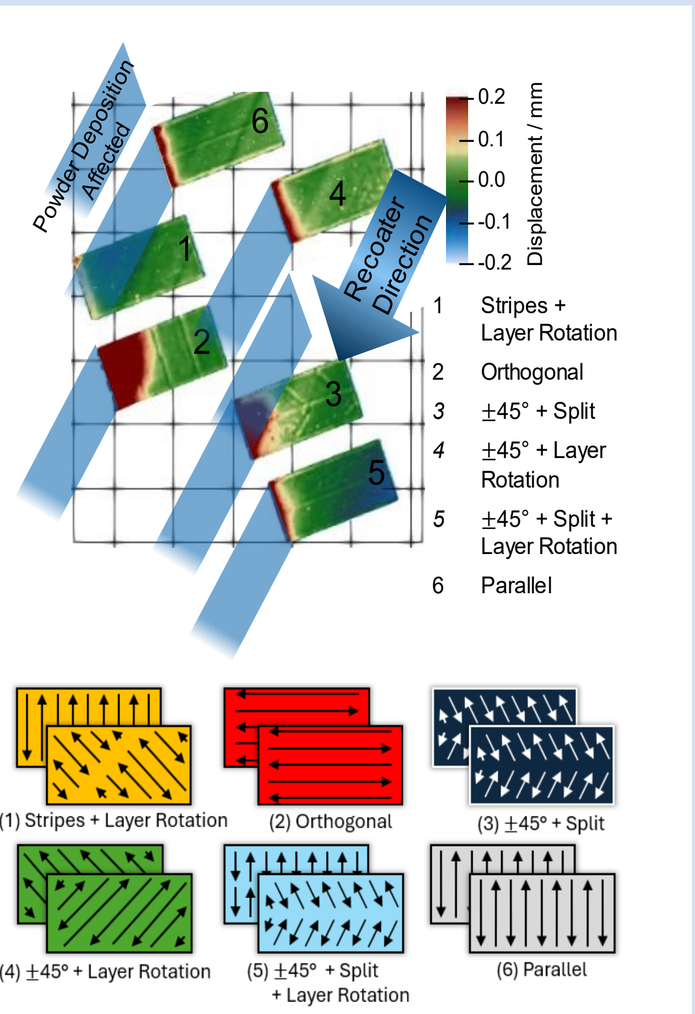

Fig. 1. Strategies

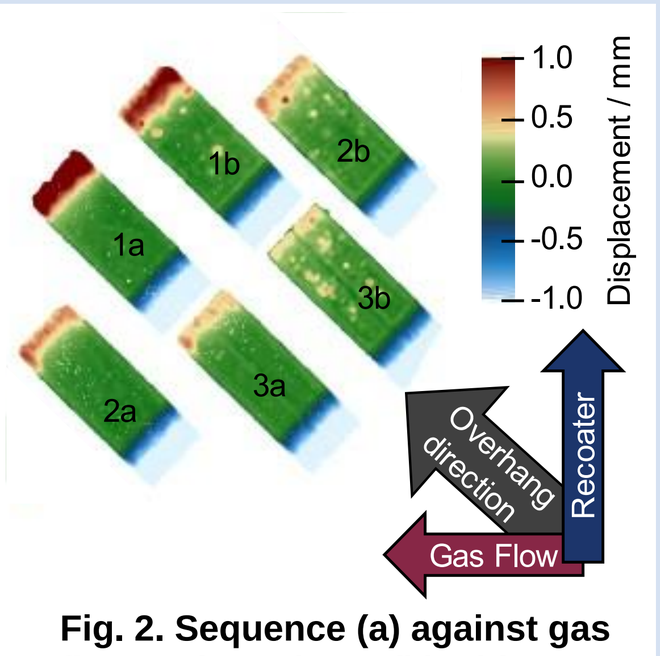

Fig. 2. Sequence (a) against gas flow and overhang (b) with gas flow towards overhang

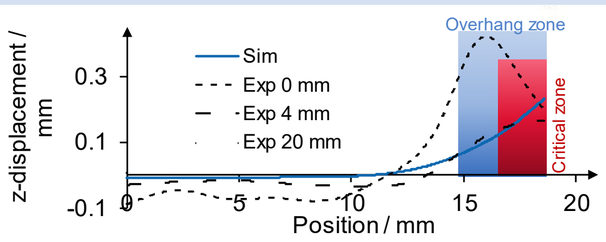

Fig. 3. Overhang zone

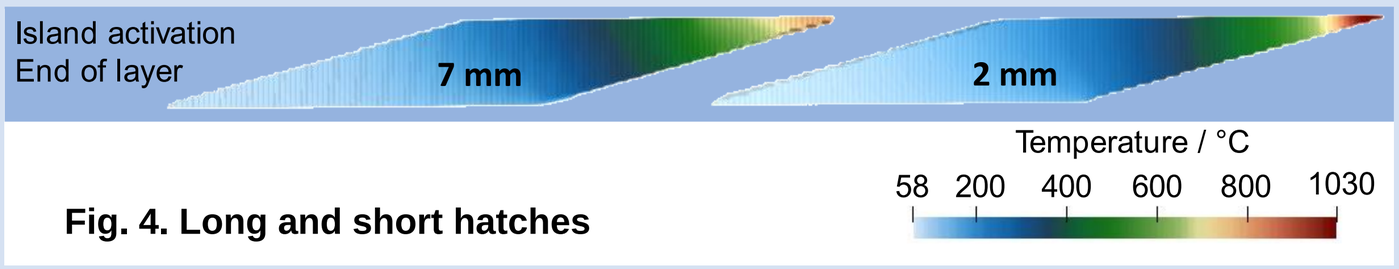

Fig. 4. Long and short hatches

Objectives

- Investigate how different hatching **strategies affect overhang displacement**.
- Use experimental and simulation approaches for validation.

Methods

- Material**: Inconel 718**, processed via PBF-LB/M.
- Machines: **TruPrint 1000 & AconityMIDI** with varied parameters (within an experiment constant).
- Geometries: 25° and 30° overhangs, support-free.
- Measurement: Structured light scanning (GOM ATOS Core 200).
- Simulations: Inherent strain and thermal (equivalent energy input model).

Experiments

Hatching Strategies Tested (Fig. 1):

Stripes, Parallel & Orthogonal to overhang, ±45° (split and layer-rotated), Checkerboard-like variations.

Variables Studied:

Sequence direction (Fig. 2), overhang zone depth (Fig. 3), and hatch length (Fig. 4).

Key Findings

1. Best & Worst Hatching Strategies (Fig. 1)

- Stripes had the lowest displacement.
- **Layer rotation** is crucial to avoid an accumulation of defects.
- Orthogonal hatching caused the highest displacement (~0.2 mm).

2. Sequence Direction (Fig. 2)

- Hatching **towards the overhang** minimizes displacement.
- **Even when against the gas flow**, it outperforms opposite sequencing.

3. Overhang Zone Depth (Fig. 3)

- A **4 mm transition zone** with parallel hatching drastically reduces displacement.
- Further increases (>4 mm) gave diminishing returns.
- The transition zone can be predicted using inherent strain simulations.

4. Hatch Length Impact (Fig. 4)

- **Longer hatches (23 mm)** reduce heat buildup and displacement.
- Shorter hatches (7 mm) cause local overheating and deformation.

Simulations

- Inherent strain simulation aligned with experimental displacement trends. (Fig. 3)
- Thermal simulation confirmed **temperature rises with shorter hatch lengths**. (Fig. 4)