NUMERICAL MODELLING OF SELECTIVE LASER MELTING BASED ON MATERIAL POINT METHOD

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Introduction to Selective Laser Melting (SLM)

1- SLM is a rapid manufacturing technique, not prototyping.

2- Used to manufacture parts especially with complex inner shapes.

3- Parts are produced layer by layer by fully melting the powders, and then solidification.

4- A laser beam is used to melt each layer of the metallic powders in each round.

5- No post processing is required for manufactured parts.

The main difficulties in SLM

1- A strong temperature gradient in the solidification layer.

2- The thermal distortion of the model during forming.

3- Internal residual stresses due to cyclic thermal expansions and contractions.

4- Formation of cracks in the model as a result of high residual stresses and reducing the fatigue life.

5- Non-linearity in material evolution/material properties .

The main inputs

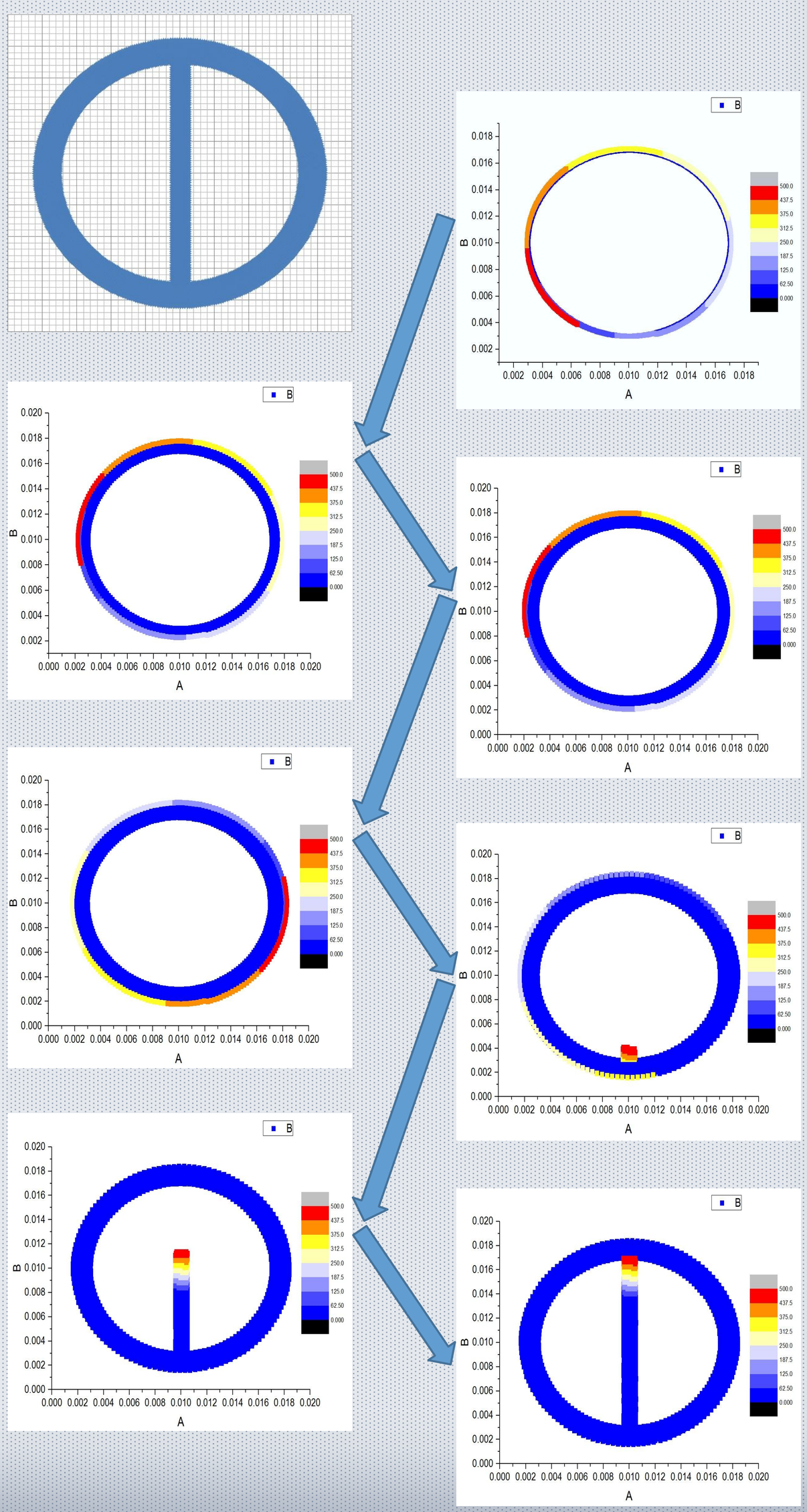
1- Powder layer thickness
2- Scan speed
3- Scan spacing
4- Powder characteristics (Size, Distribution, Shapes)
5- Laser Parameters (Power, Spot size)

Numerical model

1- Same approach in welding simulations can be used in the numerical models .
2- Time dependent boundary conditions between the solid and the powders.
3- Material Point Method is perfectly capable of simulating the SLM process.
4- At each time the liquid- solid state of the powders can be found by checking the temperature of the nodes.
5- The thermal loading cause mechanical loading.
6- The plastic energy dissipation is ignorable compared to the power of the heat source (the laser).
7- The thermal expansion coefficient is temperature dependent.
8-The material yield stress is very temperature dependent.

Advantages of Material Point Method over conventional FEM

1- Easy to deal with adding material in each time step.
2- capable of simulating sufficiently large parts.
3- Perfectly capable of modelling residual stresses, temperature gradients, cracks and large deformations.



Stress analysis with respect to time and laser spot movement in 2D.