

SURFACE ROUGHNESS IN ADDITIVE MANUFACTURING

Additive manufacturing (AM) of steels is a collection of manufacturing methods where material is added to a part rather than subtracted as in for instance turning or milling. The promise of AM is to have freedom to design, e.g. to be able to make a square hole that follows a winding path – virtually impossible to produce with traditional manufacturing. Another benefit is to only use the material that is necessary to produce the intended part. Uddeholms AB has several AM-products in the product portfolio where the main technique is laser powder bed fusion wherein a powder is raked out onto a bed and a laser is used to selectively melt the powder and, layer-by-layer, build up the part. As the powder is molten and fused in the previous layer, the surface produced will have a roughness related to this process, where parameters such as the type of steel, powder particle size distribution, laser power and speed, and other parameters, will affect the resulting roughness. This is not a big problem for surfaces that can be refined, however if an internal surface is created in a part, such as a cooling channel in a die casting tool, then it may be impossible to refine the surface. If the surface roughness of an internal cooling channel is too large, this could be a tool life limiting issue.

Problem statement:

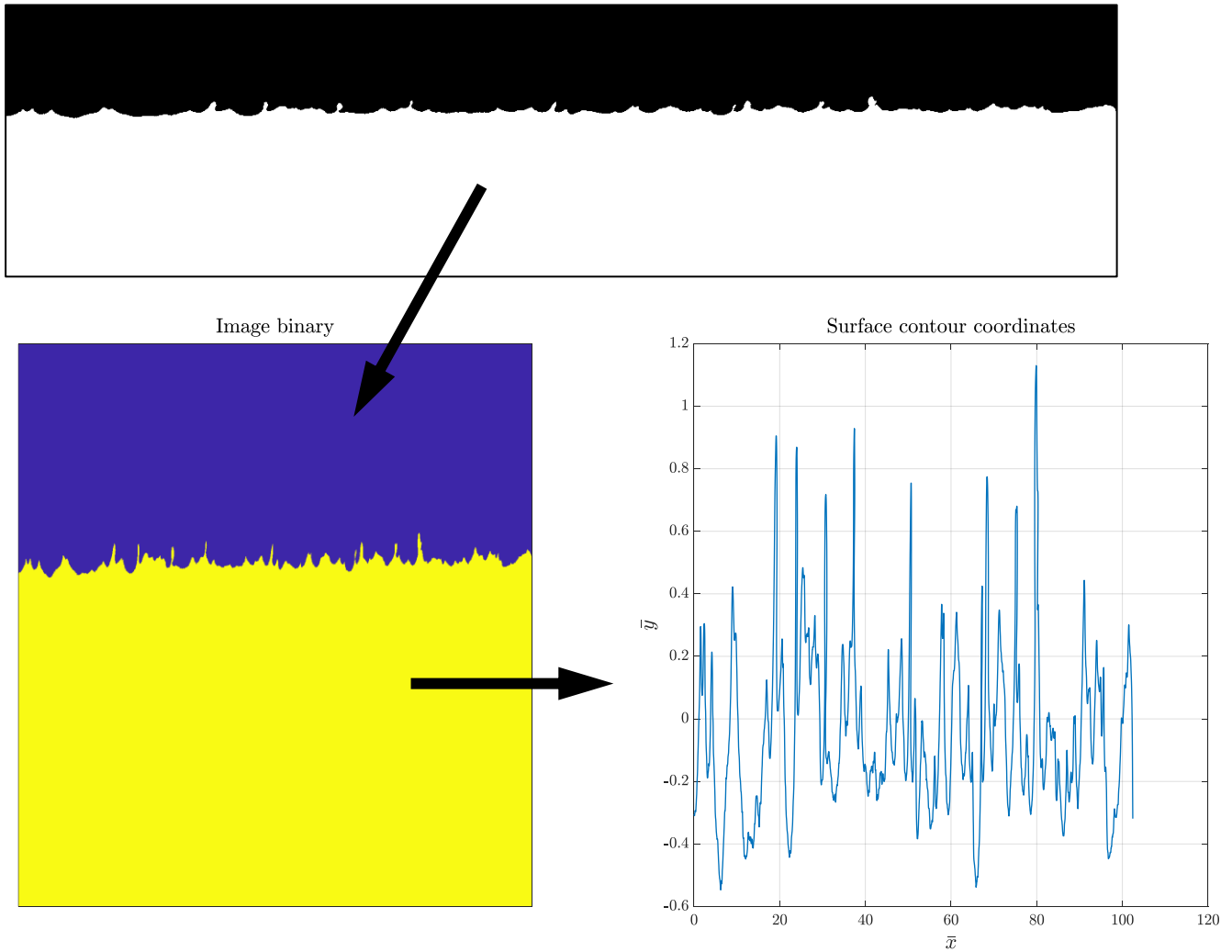
Find a method to artificially reproduce the surface roughness of an AM-produced part. Attached to this statement, a number of cross-sectional cut outs of surfaces can be found. These are supplied in order to be used as a guide for the problem statement. Attached is also a powder size distribution that has been experimentally determined for the powder used to manufacture the cross-sectional cut outs.

Solution suggestions:

- Stochastic differential equation
 - How do we include the effect of the powder particles melting together?
- Monte Carlo simulation
 - Place randomly drawn powder particles in a grid (maybe with stochastic grid sizing?) and “fuse” them together somehow?
 - Outline the surface

The images below show a cross-section cut out of an AM-manufactured surface where the building direction is along the horizontal direction in the image. The image has been introduced into Matlab and then the surface coordinates have been extracted into the diagram that is the last figure in the series. The diagram has normalized coordinates.

Image taken from microscope. White is steel. Boundary between black and white is the surface.



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