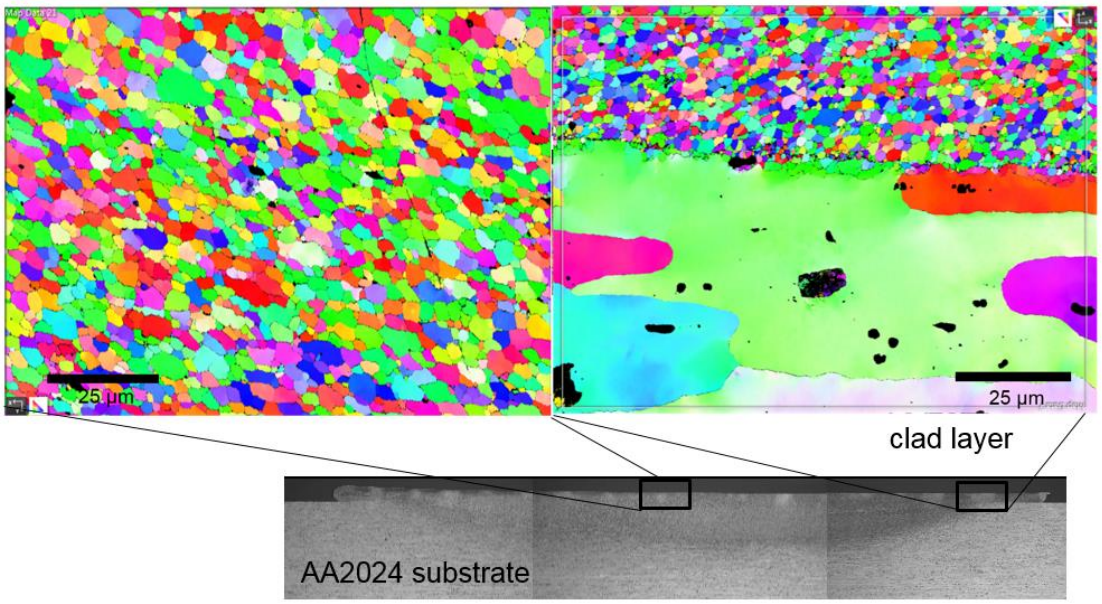
Solid state additive manufacturing of aluminium alloys
Microstructure development and residual stress (2 positions)

Additive manufacturing of high strength aluminium alloys by fusion based approaches is often limited by the occurrence of solidification related defects. Solid based approaches form a worthwhile alternative where the temperature during deposition remains below the respective metal points of the materials involved. This may lead to lower heat input and to a fine microstructure positively influencing the mechanical properties (strength, toughness) of the manufactured product (see below).



In these research projects the relations between the microstructure of deposited (clad) layers, internal residual stresses and the deposition conditions of the in-house developed solid state Friction Surface Cladding (FSC) technology is investigated. The tool rotation rate, the layer thickness, the layer width and the tool angle are known to have a strong influence on the temperature and pressure distribution during deposition. However, how this affects the microstructure and residual stresses is not yet clear. Further optimization of the technology requires a thorough understanding of the relation between process conditions and the microstructure (*position 1*). Also the presence, type and magnitude of residual stresses needs to be further examined (*position 2*).

Objective position 1

The objective of master project 1 is to investigate the relation between process conditions and the microstructure. The following aspects should be included:

(i) Literature study on the role of process conditions on microstructure development of similar solid state processes.
(ii) Perform dedicated Friction Surface Cladding experiments and/or use existing samples to characterize the microstructure in terms of grain size and distribution. Possible experimental facilities include Light Microscopy, Scanning Electron Microscopy and X-ray Diffraction.
(iii) Establish (model based) relations between relevant microstructural features and the process conditions to support microstructural optimization of the FSC process.

Objective position 2

The objective of master project 2 is to investigate the relation between process conditions and the occurrence of residual stresses. The following aspects should be included:

(i) Literature study on the role of process conditions on residual stress development of similar solid state processes.
(ii) Perform dedicated Friction Surface Cladding experiments and/or use existing samples to characterize the residual stress. Various approaches can be used including process induced shape changes and X-ray diffraction.
(iii) Establish (model based) relations between residual stresses and the process conditions to support residual stress minimalization of the FSC process.

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