

## Introduction

Refill Friction Stir Spot Welding (refill FSSW) is a solid-state technology which is capable of joining two or more materials in a spot-like lap joint configuration. Due to its advantages such as solid-state welding, less energy consumption, compatible with dissimilar materials, and superior mechanical properties for the resultant joints, the process is especially applicable to difficult-to-weld and non-weldable alloys, e.g., lightweight alloys that widely used in the automotive as well as the aircraft and aerospace industries. In this areas, therefore, Refill FSSW is considered as a potential alternative to mechanical fastening and resistance spot welding.

The aim of this thesis is to realise sound welds of consistent quality and excellent mechanical properties on the basis of understanding of formation mechanisms of weld imperfections. More specifically, the factors and their significances that could impact lack of refill will be determined by Design of Experiment; the development of lack of refill in the course of welding will be captured by revealing the materials flow at each stage; on these basis, the welding process will be optimized with the objectives of maximizing the joint cross-tension strength and minimizing the standard deviation of it.

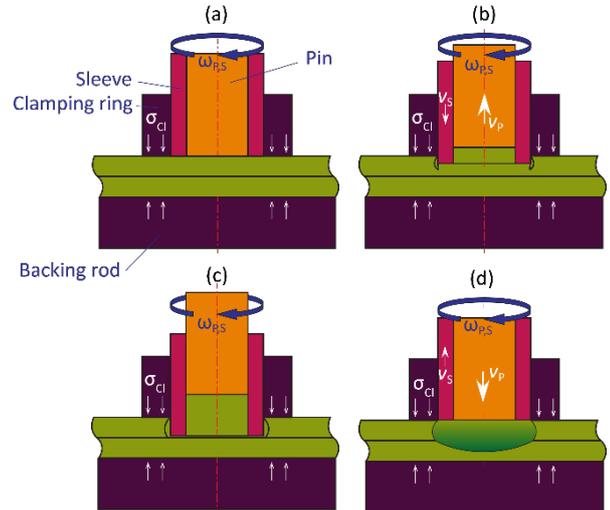
The place of employment would be the Helmholtz-Zentrum Geesthacht, located at Geesthacht.

## Tasks

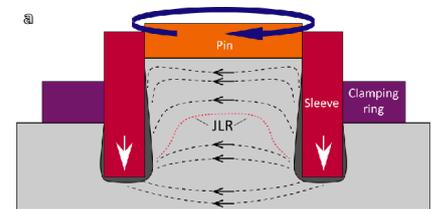
- Literature research (refill FSSW and design of experiment).
- Metallurgical preparations and analysis of resulting welded specimens.
- Development of the experimental design and execution of the desired experiments including welding experiments, cross-tension experiments, and hardness test experiments.
- Presentation of the results and documentation of the experimental work (in English).
- Optional: to produce lap-shear samples and fully-stacked samples for further mechanical tests and investigations.

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The principle of refill FSSW process. First, the clamping ring holds the materials against the backing. Then, the sleeve rotates and plunges downward into the material to the desired depth, while the rotating pin simultaneously moves upward. After a certain time (not mandatory), the rotating sleeve and pin return to their initial positions, refilling the keyhole with the softened rod, resulting in a keyhole-free joint.



Schematic diagram illustrating the material flow in the transverse cross section at the plunging stage (material flow lines are indicated by dashed lines with the flow direction indicated by black arrows. The white arrows show the moving direction of the sleeve)