FSW-Tech

Friction Stir Welding European Qualifications

CU3 – Process Operation

FSW Operator

Co-funded by the
Erasmus+ Programme
of the European Union

3. Process Operation

3.1. Auxiliary Equipment

3.2. Problems within FSW

3.3. Actions to solve problems

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3. Welding Process Operation

- The sound welded joints is such a joint which was fabricated free from any defects.

- One of possibilities how to avoid the defects consists in application of auxiliary equipment

- The auxiliary equipment may by classified in two basic groups: navigation and hybrid

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3.1 Navigation auxiliary equipment

- Use in applications where it is necessary to control :
- the corect position of welding tool in welding line direction
- the immersion depth of welding tool
- temperature

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3.1.1 Depth control (welding tool immersion)

- The depth sensor makes use of axial force for manipulation with the depth of welding tool immersion.
- The laser sensors are used as the feedback signals for the controllers.
- Experimental results have proved that at application of auxiliary devices (sensors, probes) and a correct setting of immersion depth of welding tool the occurrence of defects like lack of root fusion and excessive flash has drastically reduced.

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3.1.1. Depth control (welding tool immersion)

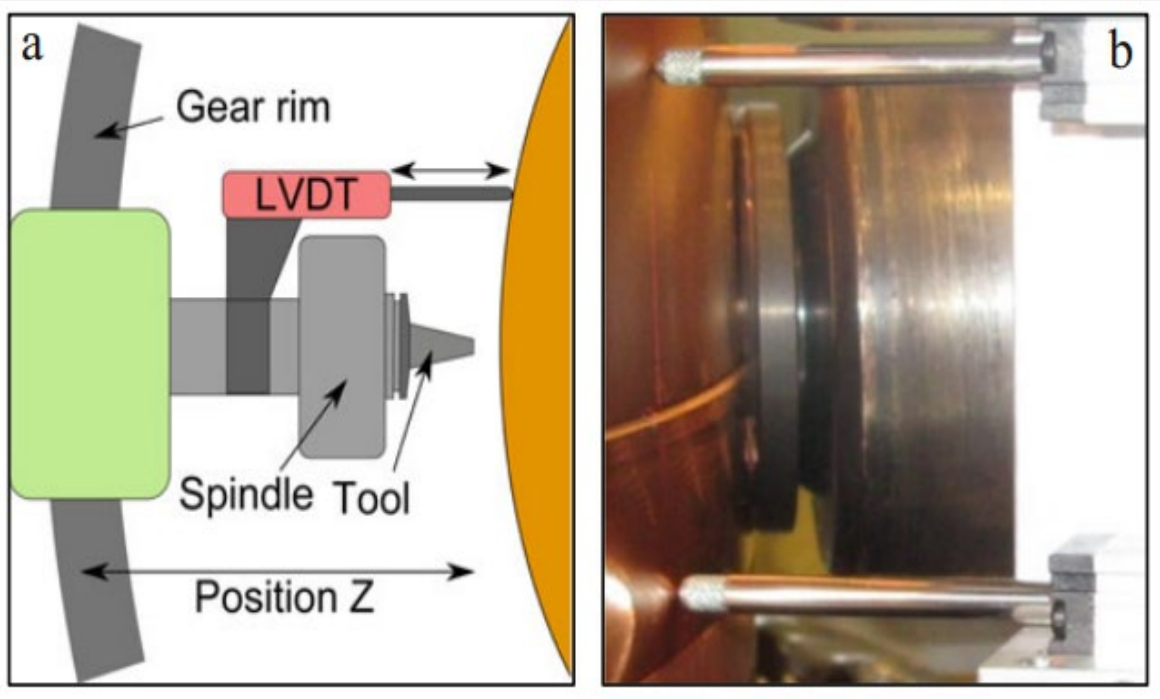

Figure 3-1 a) Configuration of depth sensor ; b) 2 Linear differential transformers

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3.1.2 Temperature control in welding by FSW process

- The temperature is measured by use of a thermo-electric signal between the tool and material welded.

- The TWT method offers an accurate temperature measurement under the tool shoulder and in the vicinity of tool fringe.

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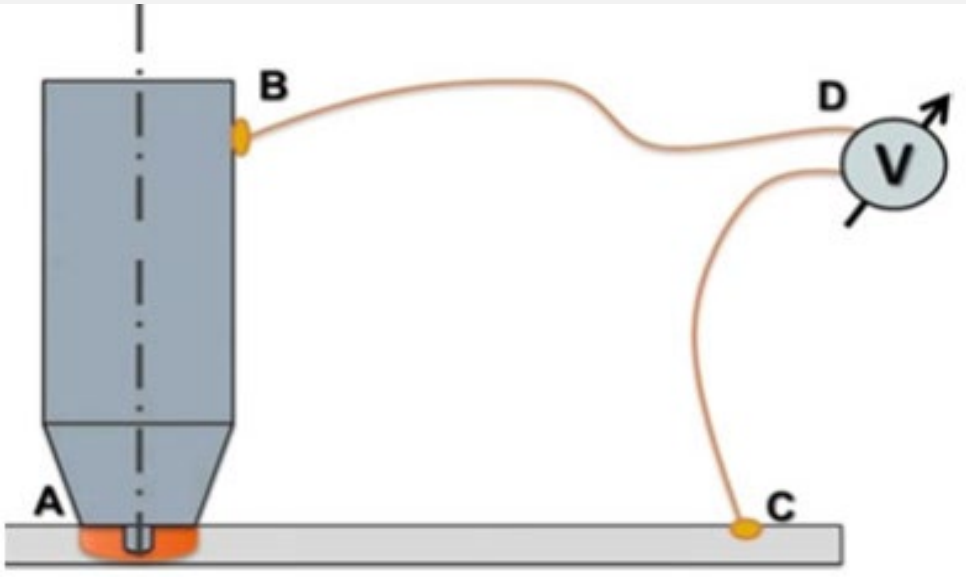

Setup for calibration of the temperature measurement method

The thermal boundary between the welding tool made of steel and welded materials of Al alloy (A). Thermo-electric potentials between the tool and welded material (B.C). The recorded difference in voltage (D).

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3.1.2 Temperature control in welding by FSW process

- Another way enhancing fabrication of quality welds consists in temperature measurement by the aid of wireless data transfer.
- The thermocouples are inserted into the welding tool together with the wireless system for data transfer.
- The thermocouples should be situated in such a manner that they would be as close as possible to the boundary between the welded material and welding tool.

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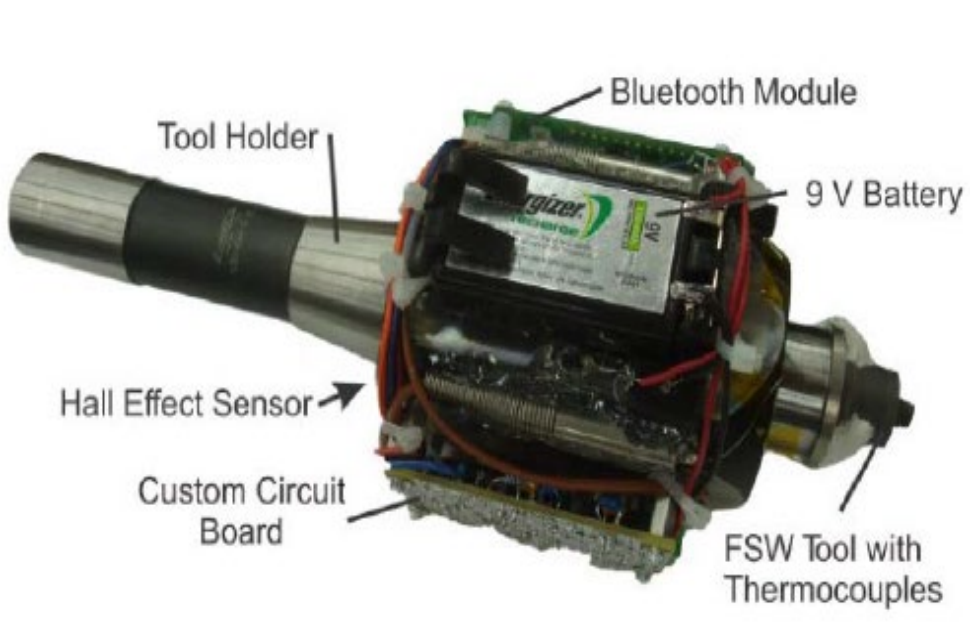
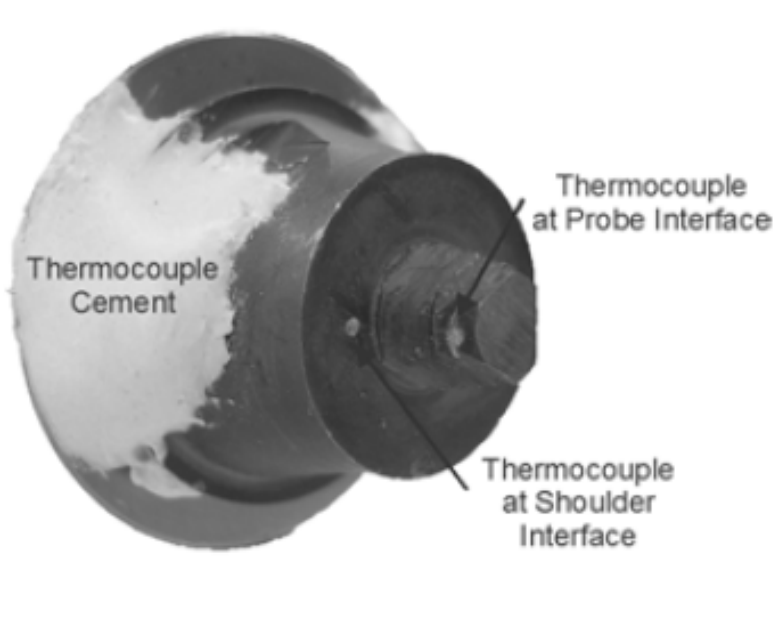
3.1.2. Temperature control in welding by FSW process



a)



b)

(a) Tool holder for FSW process distribution of thermocouples; (b) Detailed distribution of thermocouples

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3.1.3 Hybrid auxiliary equipment

- The so-called hybrid welding processed (HFSW) is getting ever popular nowadays. The friction stir welding has a lot of modifications.
- The most frequently used sources are: GTAW, laser beam, plasma beam, high-frequency heating, induction heating and ultrasound.
- These methods prolong the life of welding tools and allow a better plasticizing of material welded.

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3.1.3 Hybrid auxiliary equipment

HFSW equipment with participation of a GTAW heat source

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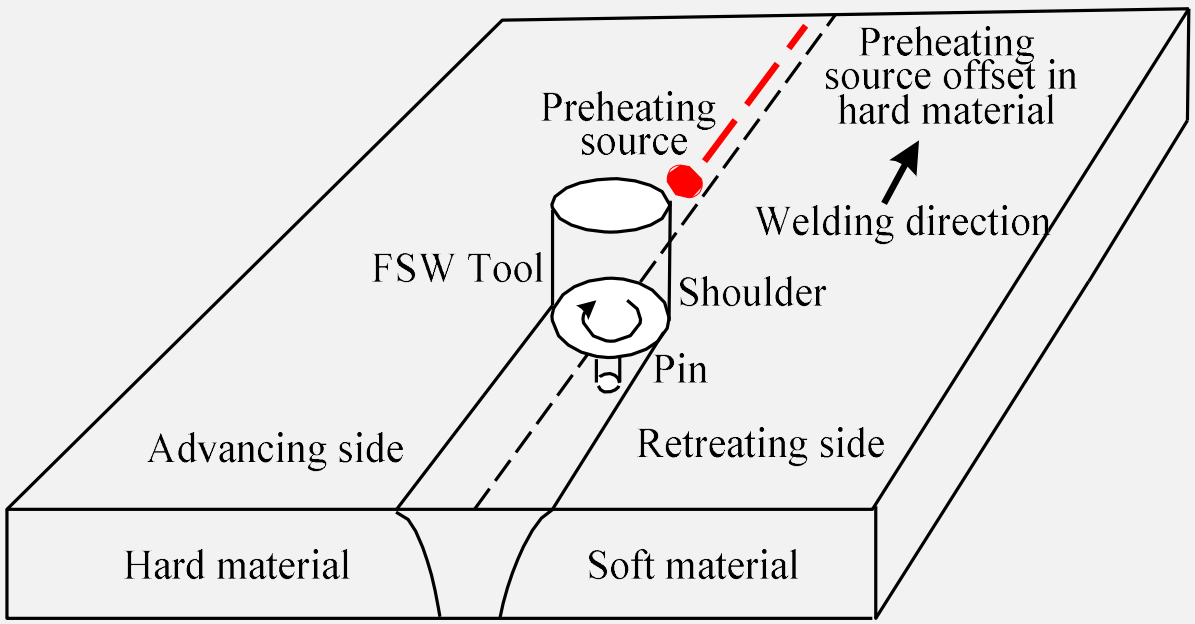

Basic principles of plasma-assisted friction stir welding of dissimilar joint

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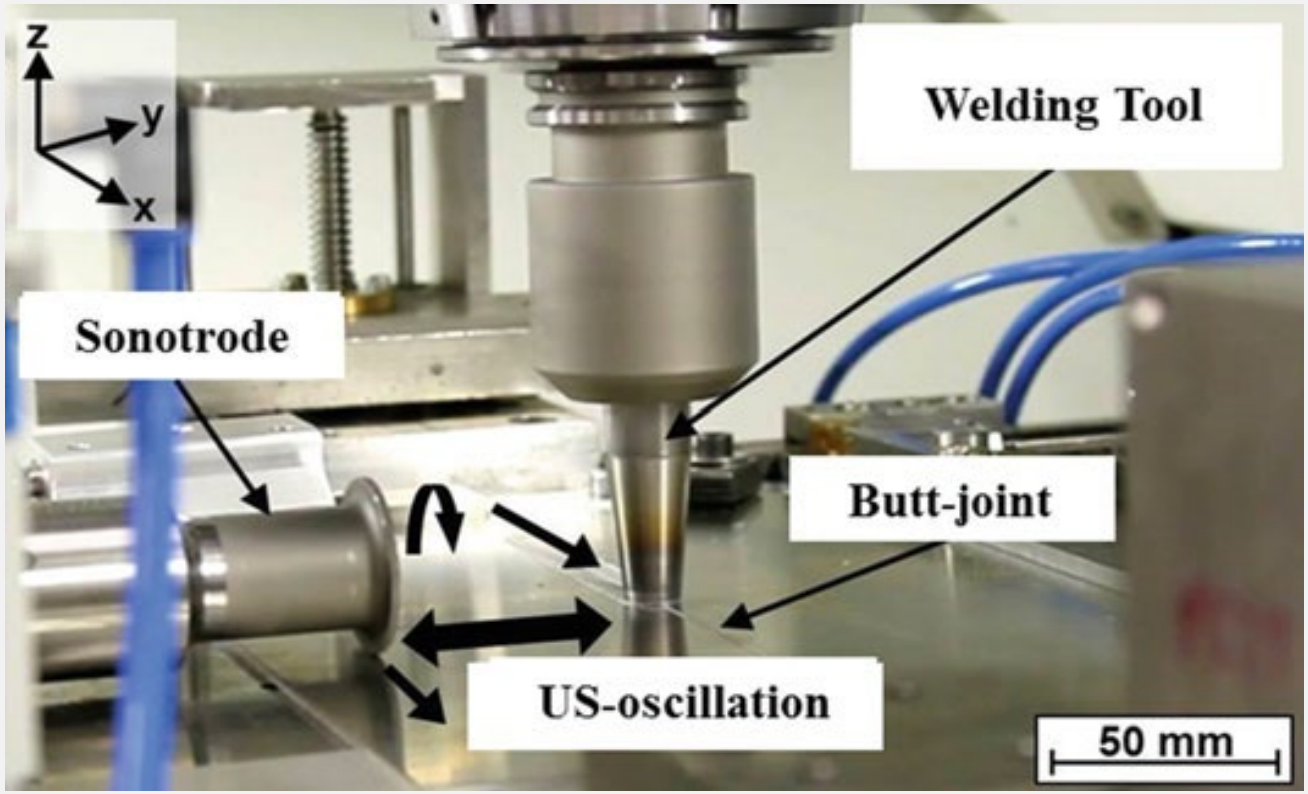

Welding by use of USE-FSW hybrid technology

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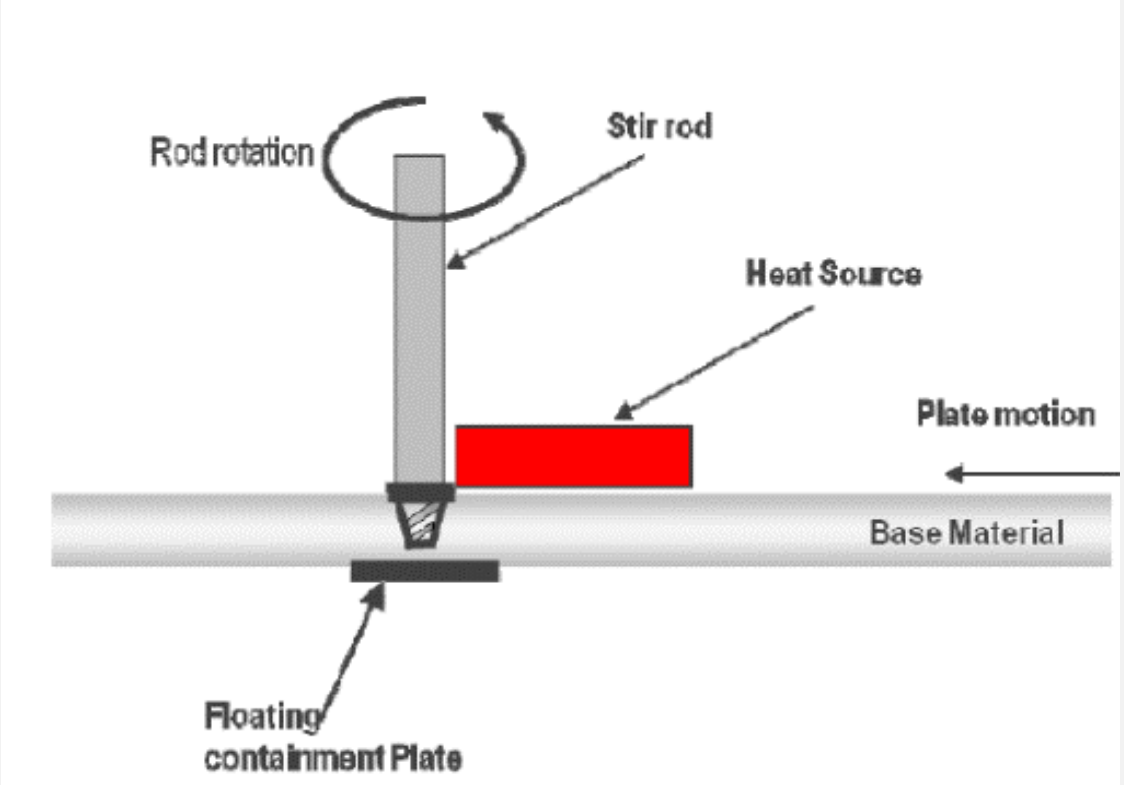

TSW terminology showing the tool during a weld

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3.1.3 Hybrid auxiliary equipment

- It can be surely stated that the hybrid processes (with auxiliary equipment) are suitable means for achieving sound welded joints and prolonging the life of welding tools

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3.2 Problems within FSW

- FSW is a modification of friction welding, where actually all defects occurring in the fusion processes, including the laser and other concentrated power sources are absent.

- The most frequent defects as the hot cracking and porosity do not occur in FSW process because this is a solid state joining process.

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3.2.1 Most common basic problems

- The insufficient stirring of welded materials, voids, excessive flash and cracks may be included among the most common basic problems

- The defects are classified to the internal and surface defects

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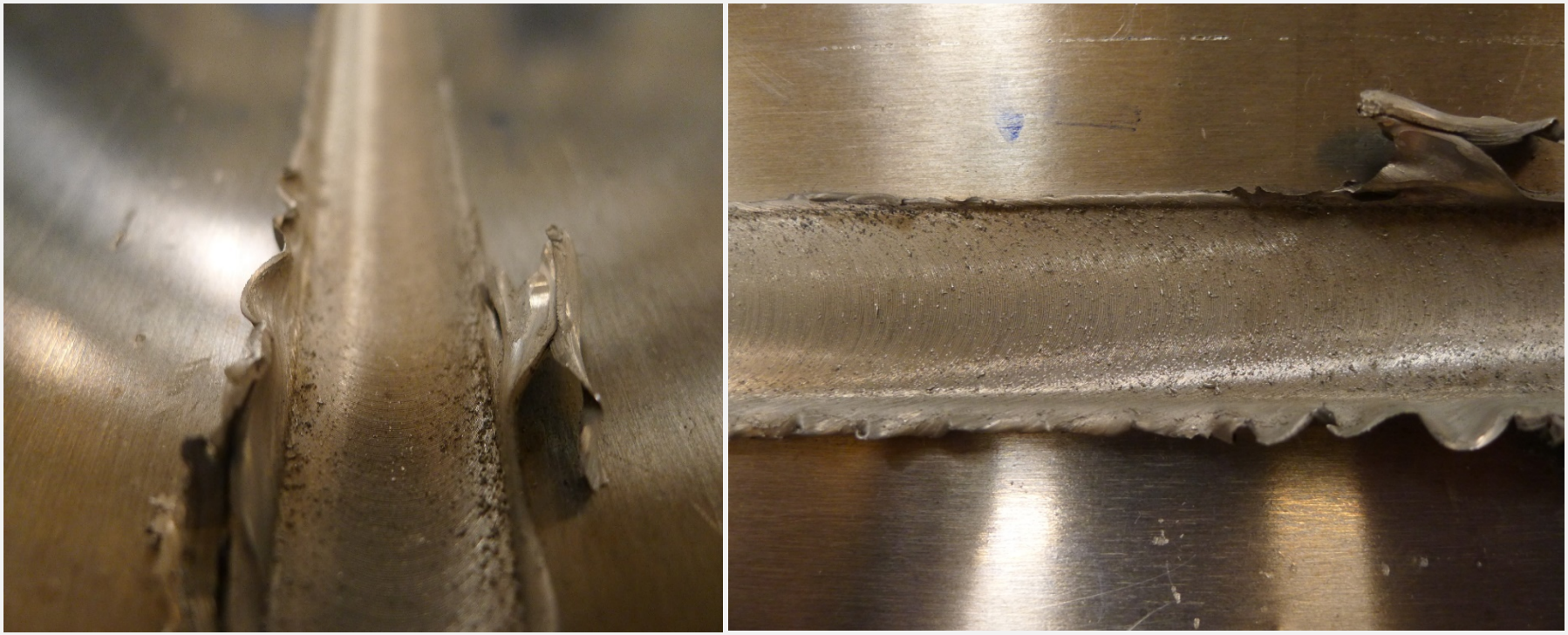

Welding joint– flash

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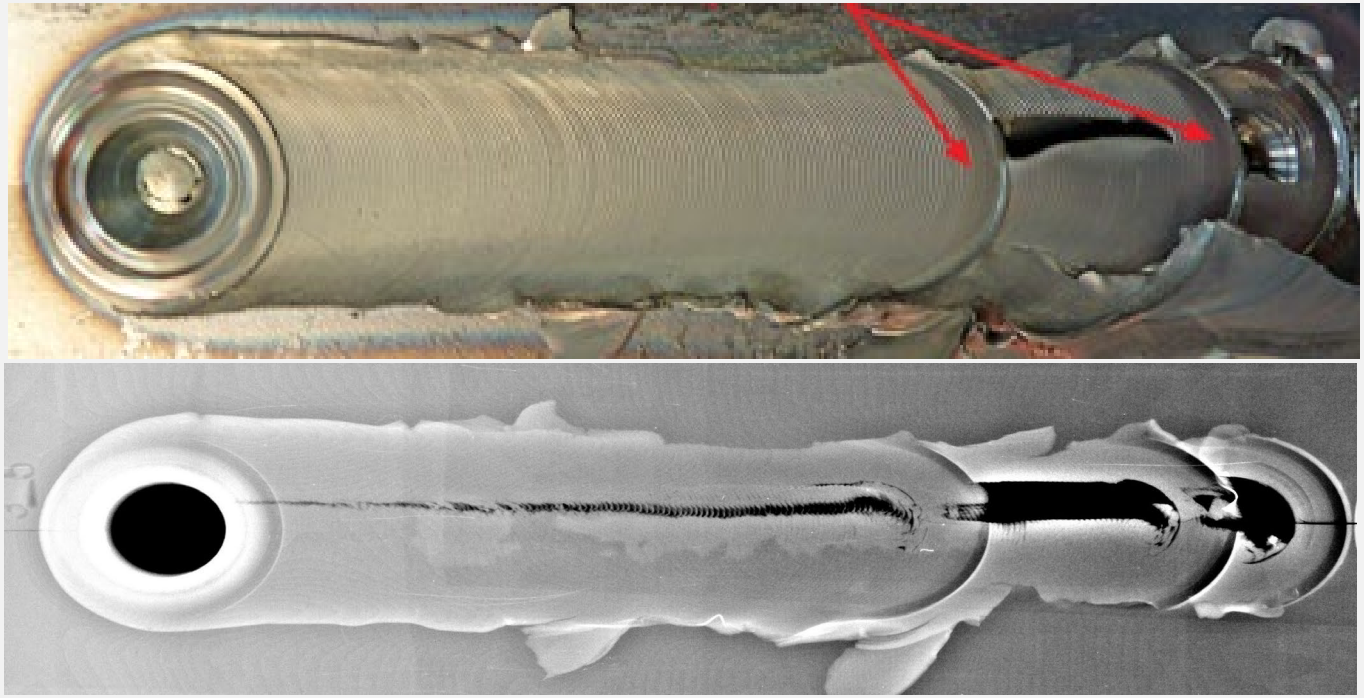

Defects - Voids

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3.3 Action to solve problems

- The excessive material – flash may be included among the most frequent defects.
- The main reason for excessive flash formation consist in excessive depth of welding tool in material thickness directions.
- This drawback can be corrected by a suitable setting of inclination angle of welding tool.

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3.3 Action to solve problems

- In the case if not sufficient heat, needed for plasticizing the material welded is supplied to weld zone, the defect, defects called the voids are formed in welded joints.

- It was experimentally proved that with enlarging diameter of welding tool shoulder a great heat volume enters to welding process, what results in better plasticizing of welded material and thus the defects occurrence in welded joints is prevented.

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Conclusion

- It may be thus stated that effective selection of welding parameters eliminates the formation of mentioned defects what contributes to improvement of mechanical properties of weld joints.

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