

Experiences in welding dissimilar materials, especially aluminium-steel welds – with regard to macroscopic effects

I2FG workshop, May 7th, Gent

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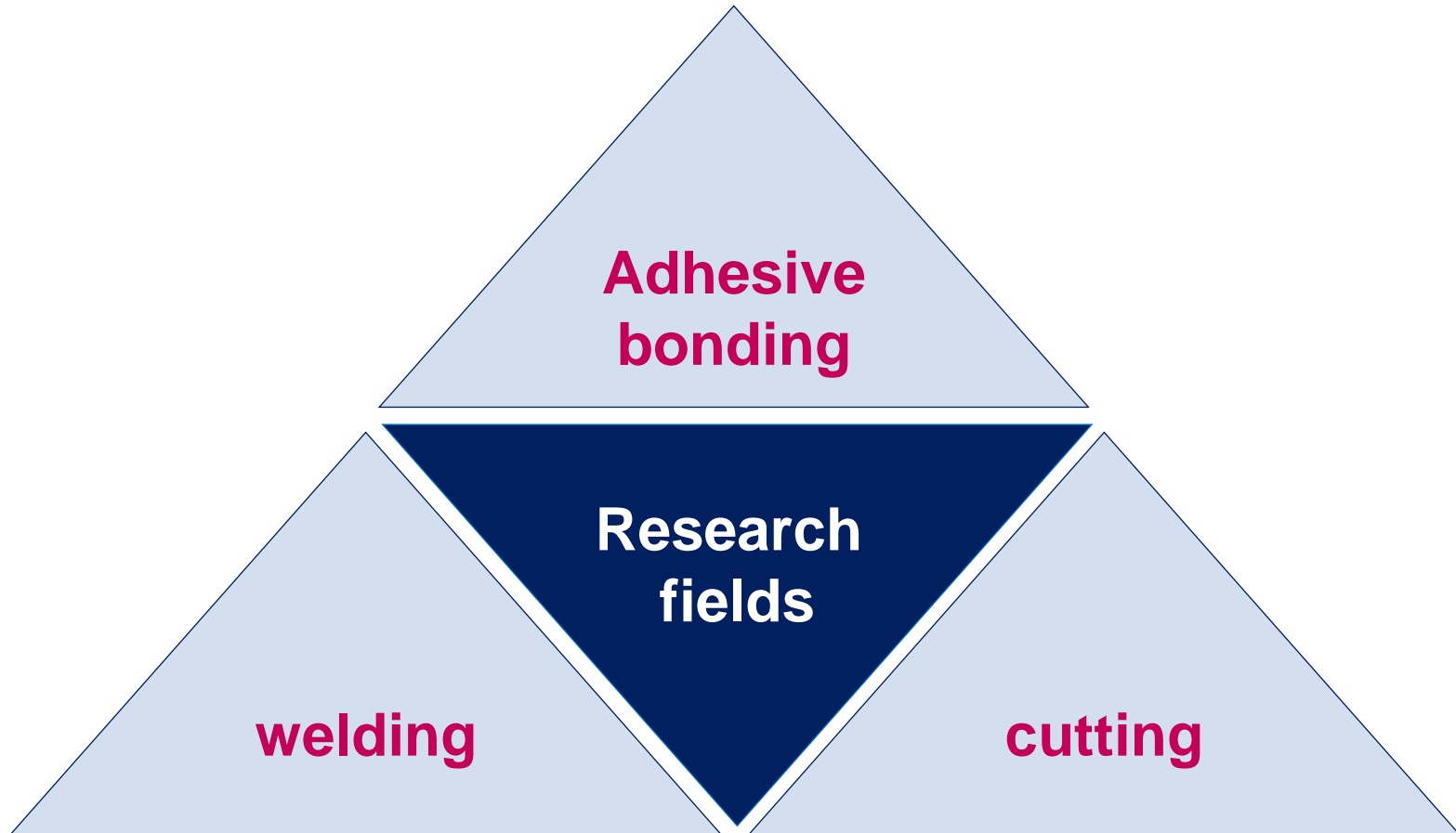
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Agenda

- Introduction
- Welding of tubular structures: aluminum-steel, aluminum-copper
 - Impact of charging energy
 - Impact of insertion point
 - Impact of surface roughness
- Welding of sheet material, aluminium-steel welds
 - Process window for aluminium-steel sheet welds
 - Distribution for weld length, strength and relative position
 - Impact of grain orientation and structure

Working Units: Group of joining and cutting technologies



Magnetic Puls Equipment at University of Kassel

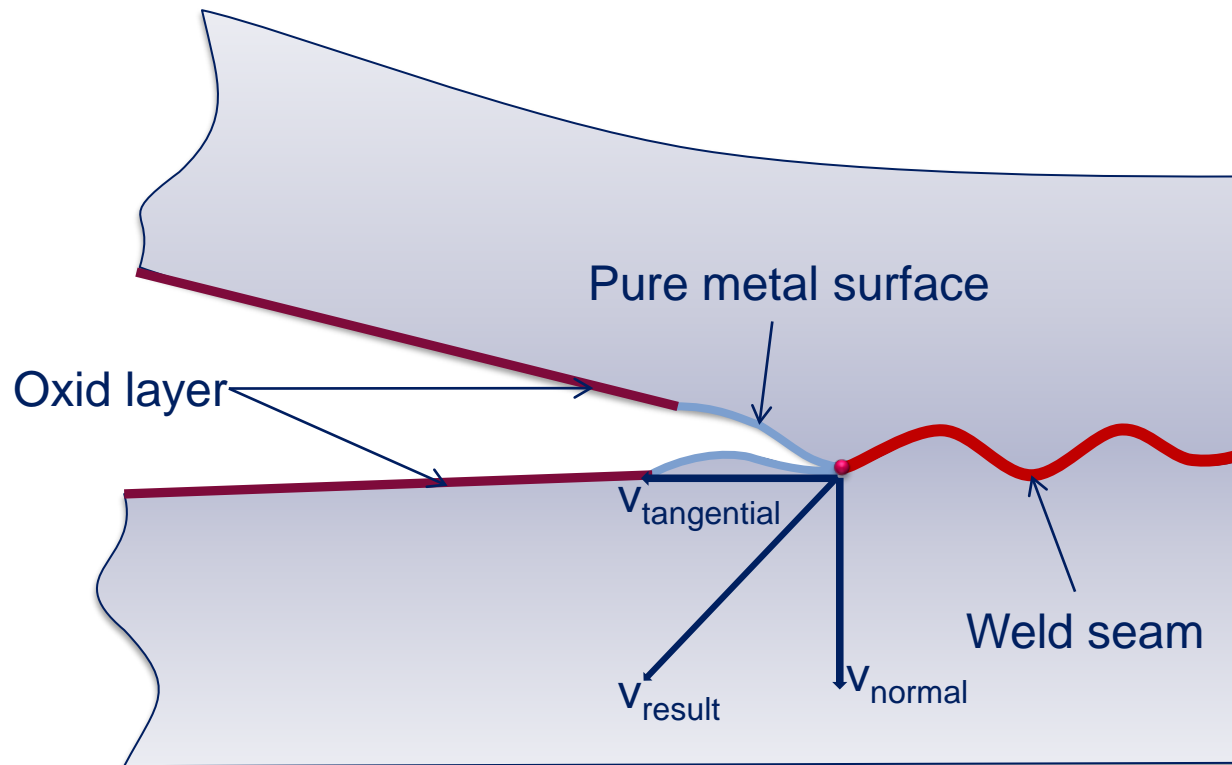
PS 48-16, pstproducts GmbH



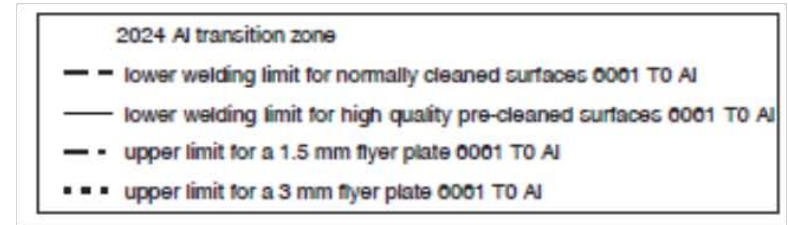
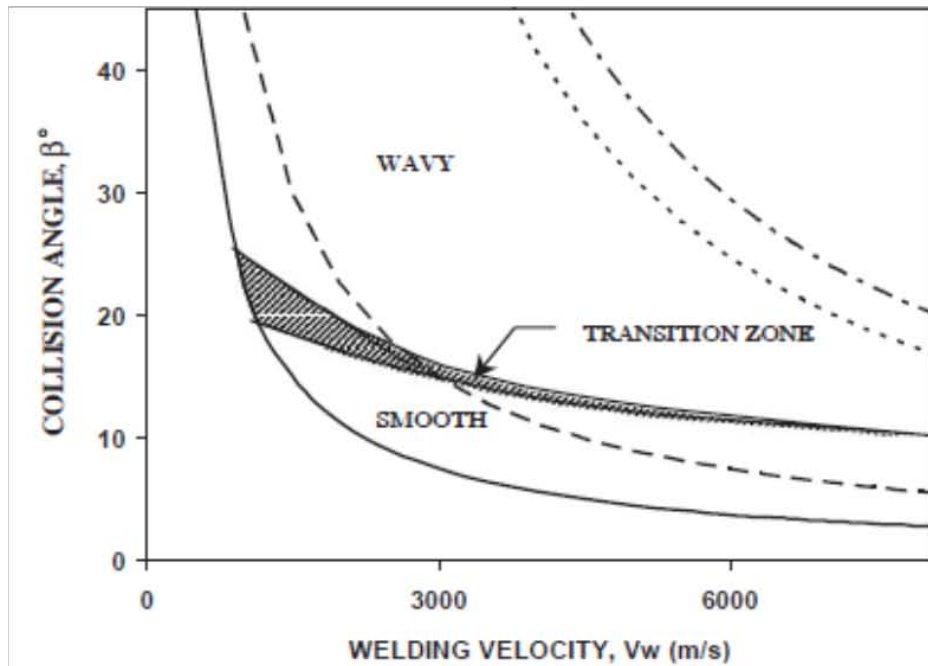
machine

- 52 kJ charging energy
- 16 kV charging voltage
- round coil
- flat coil

Welding process



welding window for impact welding



[Dissimilar Metal Joining: Macro- and Microscopic Effects of MPW; G. GÖBEL, et.al.]

Agenda

■ Introduction

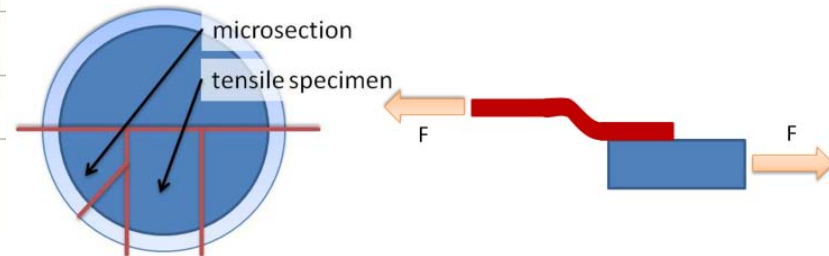
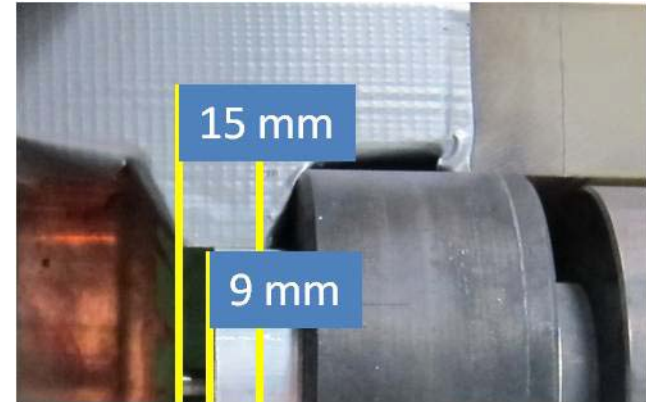
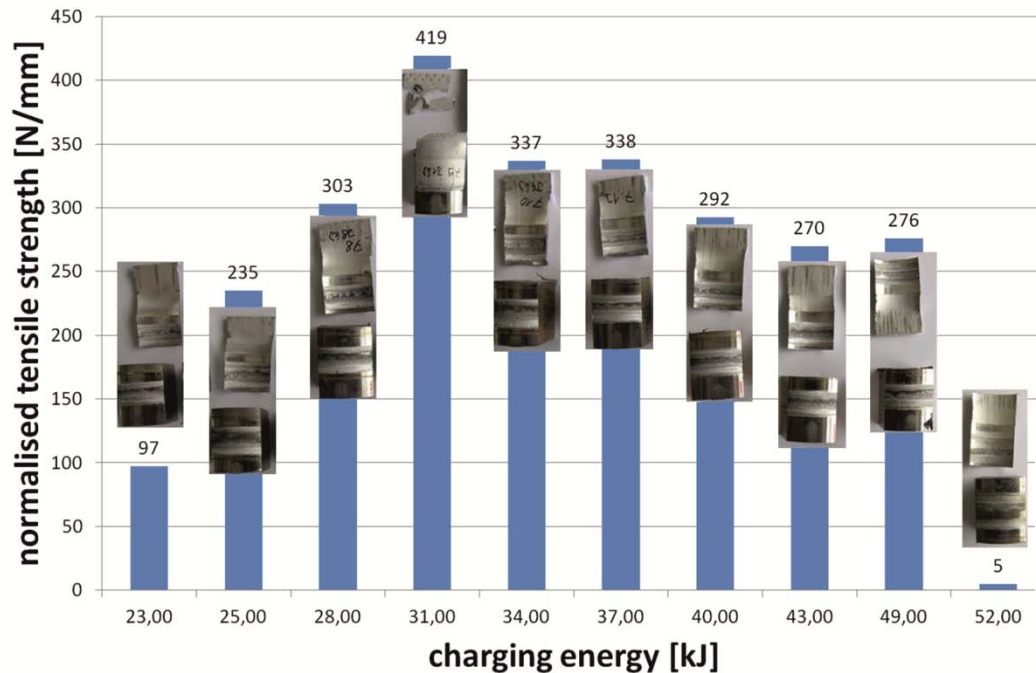
■ Welding of tubular structures: aluminum-steel, aluminum-sopper

- Impact of charging energy
- Impact of insertion point
- Impact of surface roughness

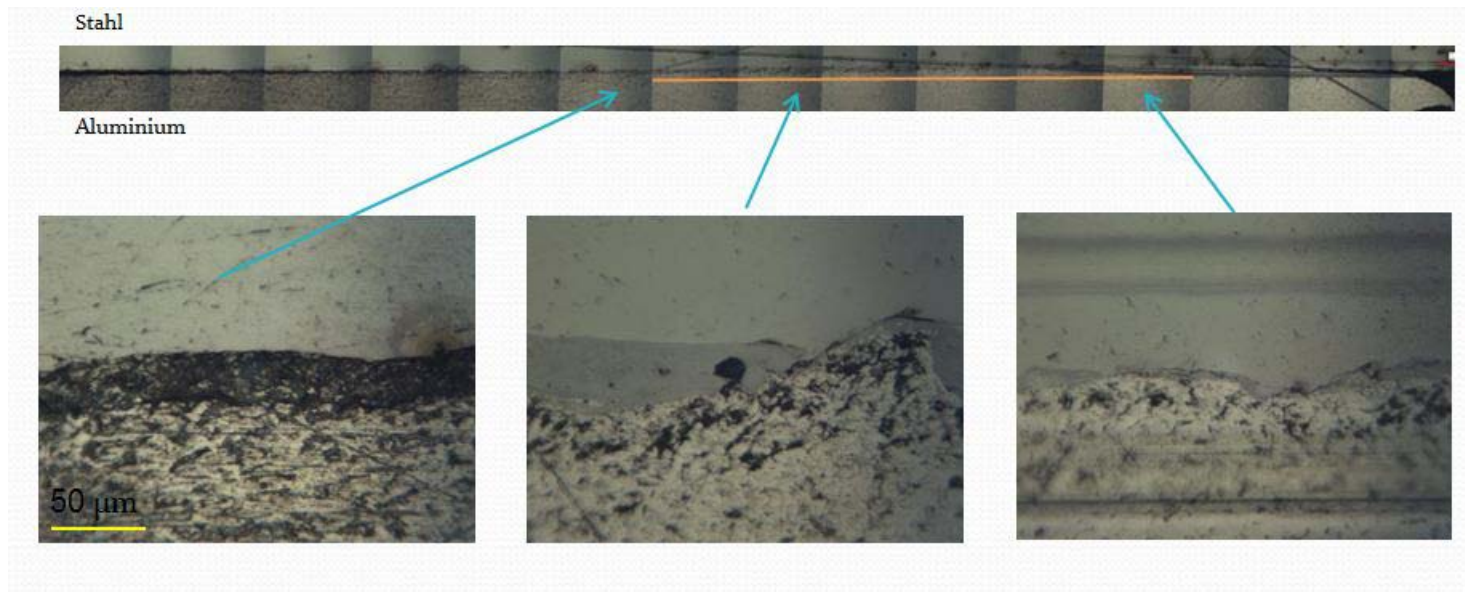
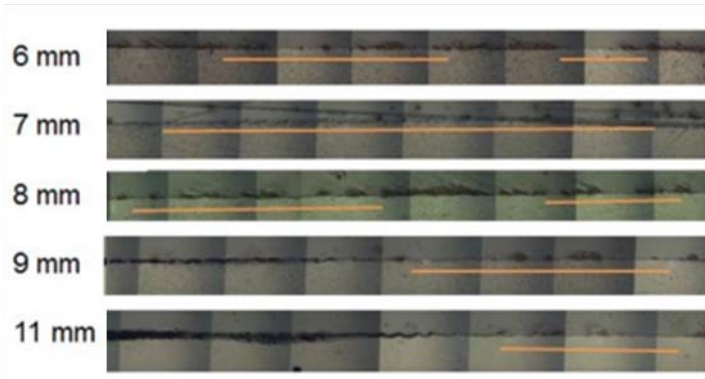
■ Welding of sheet material, aluminium-steel welds

- Process window for aluminium-steel sheet welds
- Distribution for weld length, strength and relative position
- Impact of grain orientation and structure

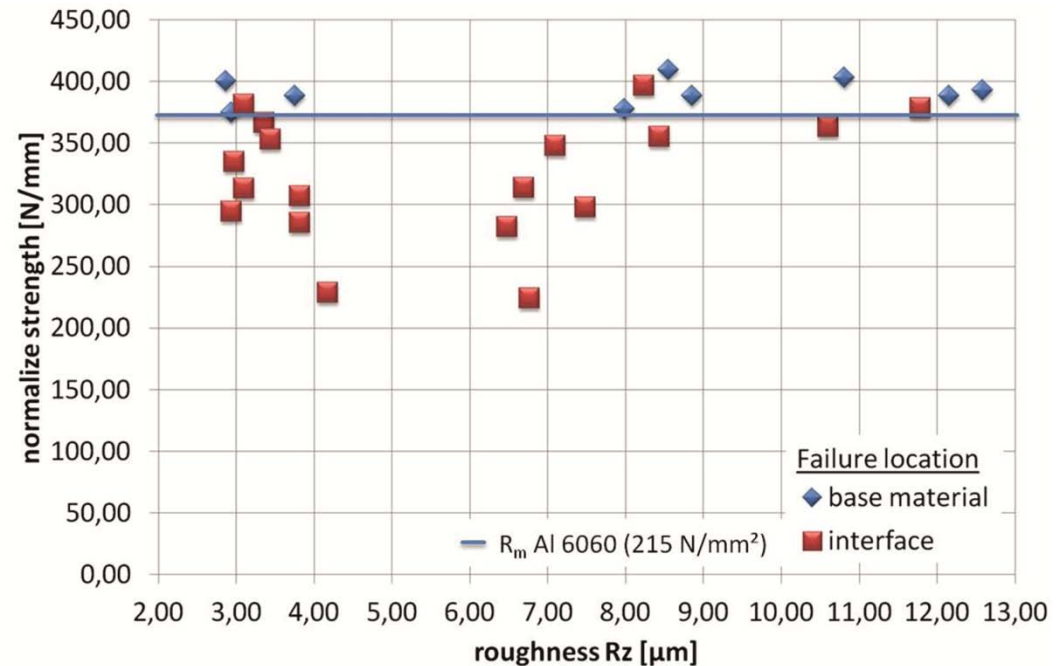
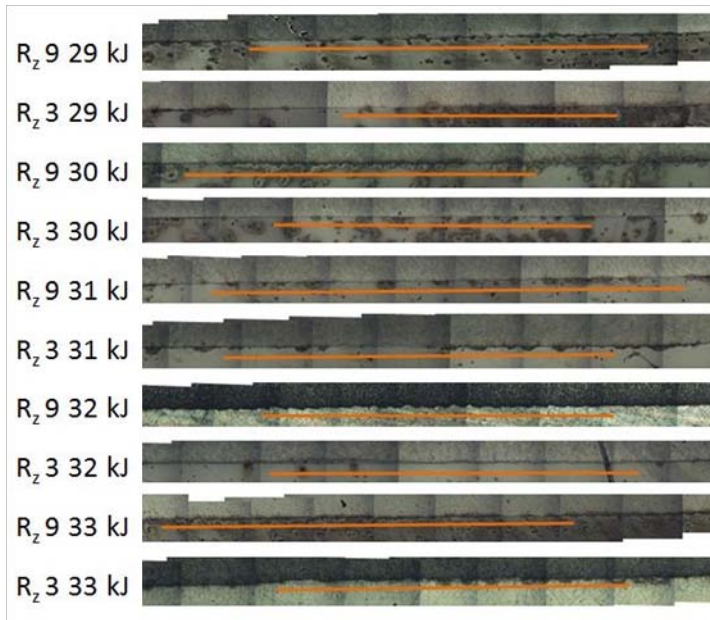
Aluminum-Steel: Process window



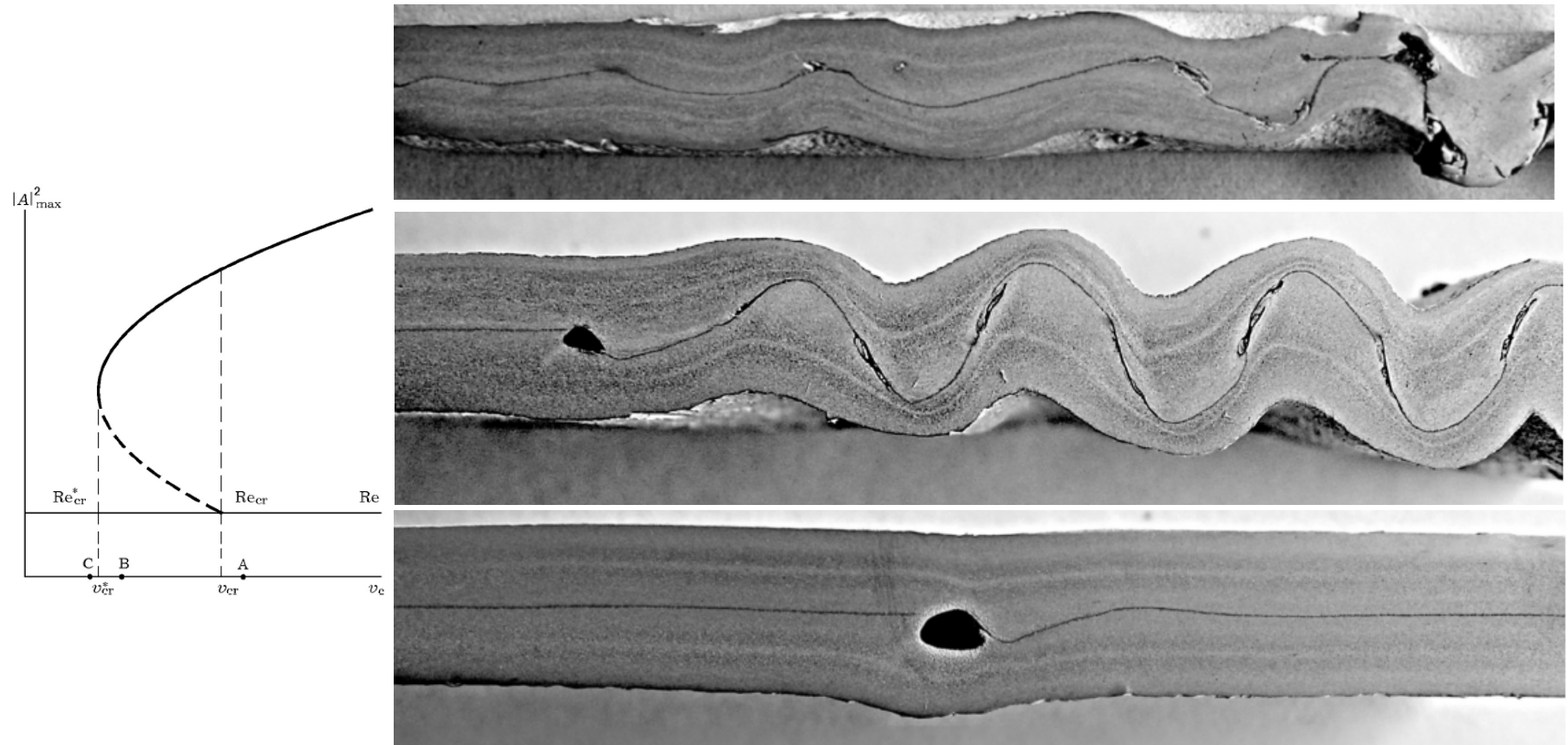
Aluminum-Steel: Impact of insertion point



Aluminum-Steel: Impact of surface roughness

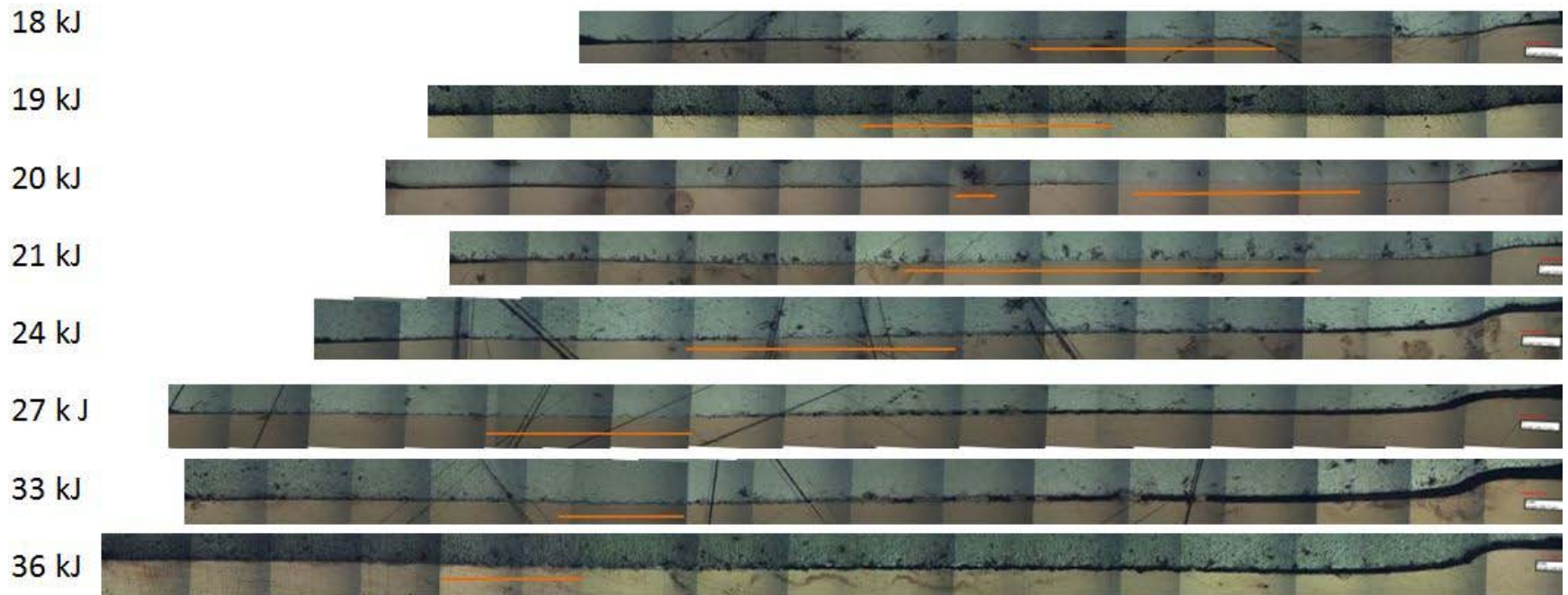


Possible explanation [Pai, Luk'yanov et.al.]

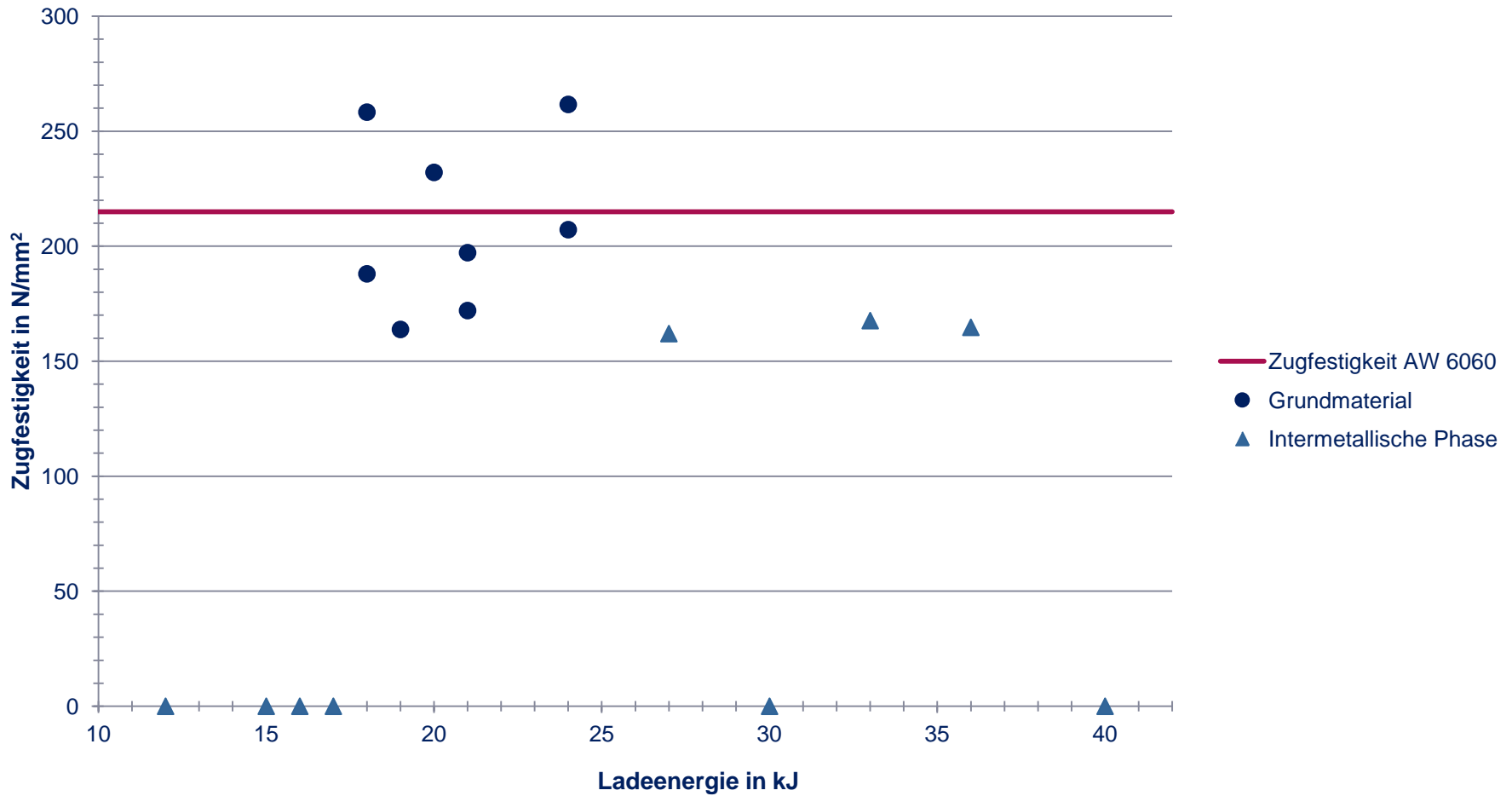


[Pai, Luk'yanov: Wave Formation in a High-Velocity Symmetric Impact of Metal Plates]

Aluminum-Copper: Impact of charging energy



Aluminum-Copper: Tensile strength



Aluminium-Copper: Impact of roughness



Oberflächenrauigkeit	Zugfestigkeit	Schweißnahtlänge	Beginn der Naht
R _z 3	213,2 N/mm ²	2,94 mm	7,15 mm
R _z 3	146,0 N/mm ²	1,90 mm	7,19 mm
R _z 6	142,8 N/mm ²	2,05 mm	6,55 mm
R _z 12	162,5 N/mm ²	2,75 mm	7,68 mm
R _z 20	177,9 N/mm ²	3,82 mm	7,66 mm

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Preparation

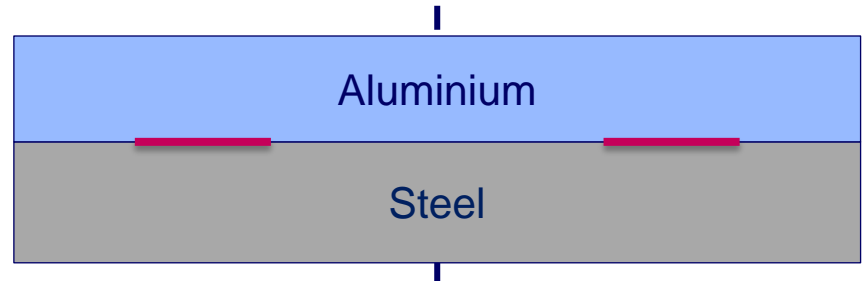
Aluminium EN AW 1050



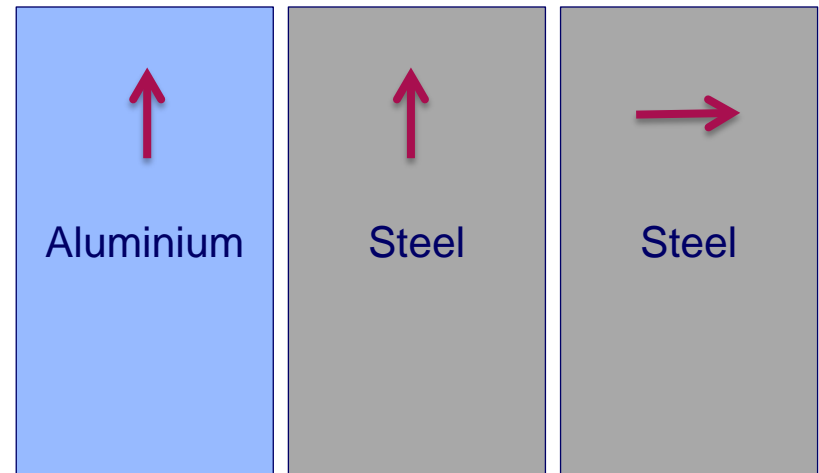
Distance 1,5 mm

Free end

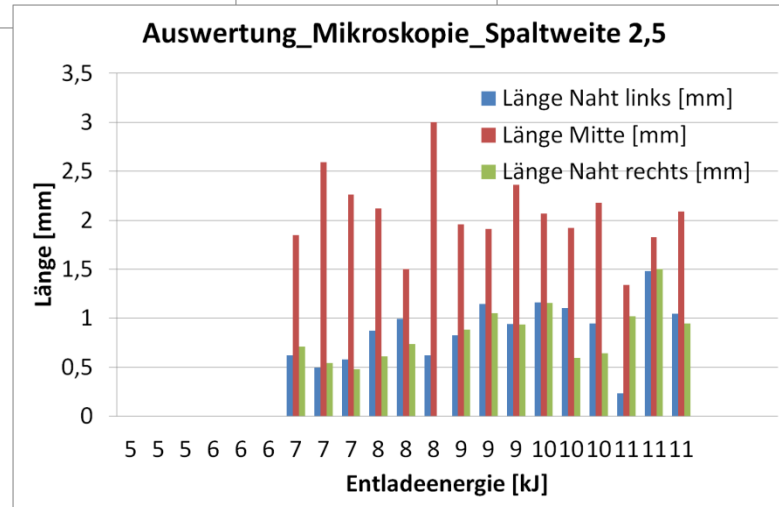
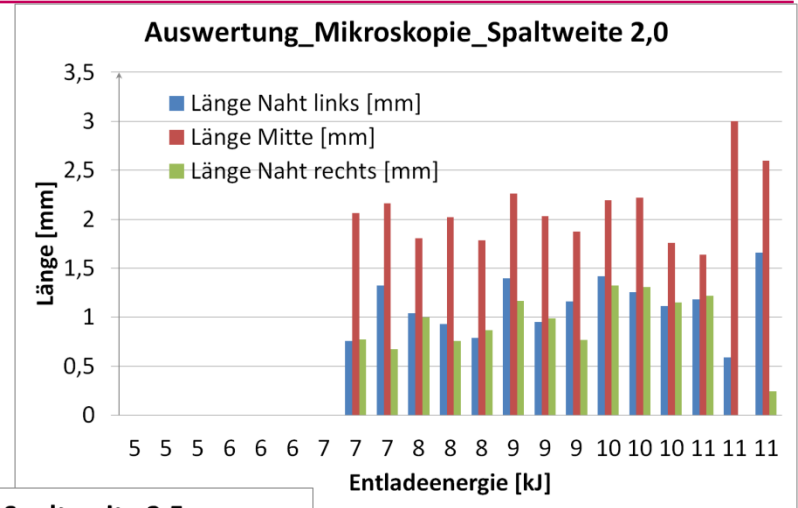
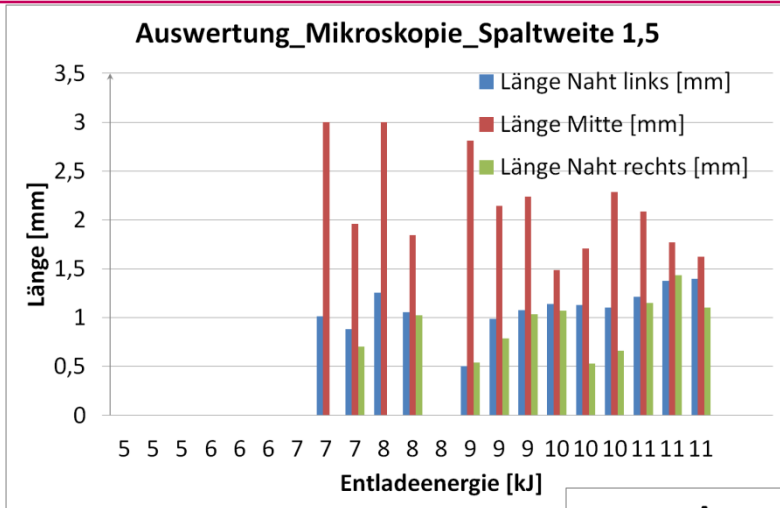
Steel S235 JR
S355 MC



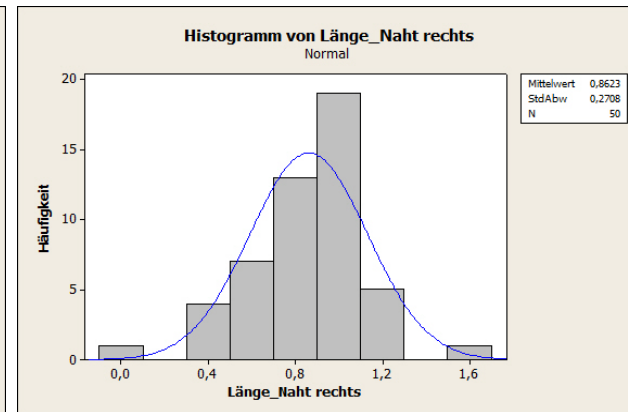
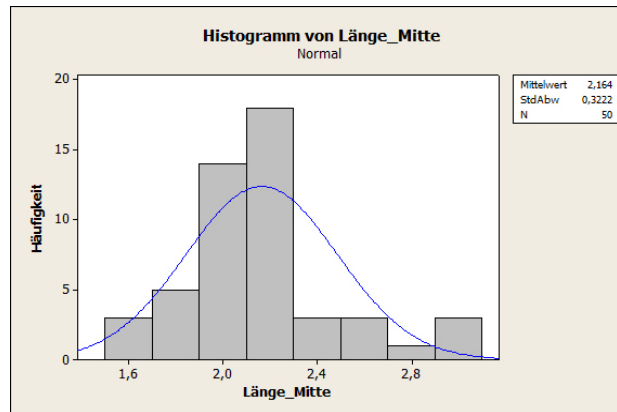
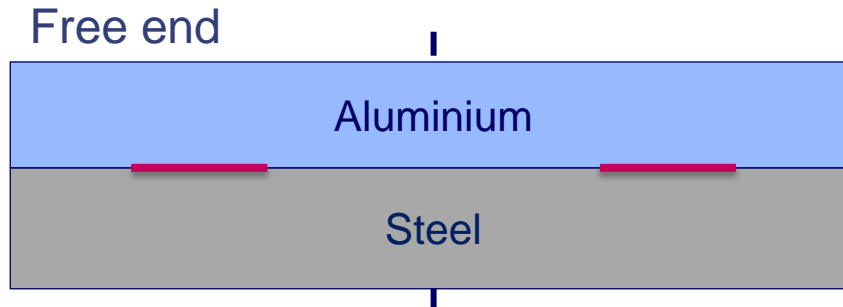
Direction of rolling



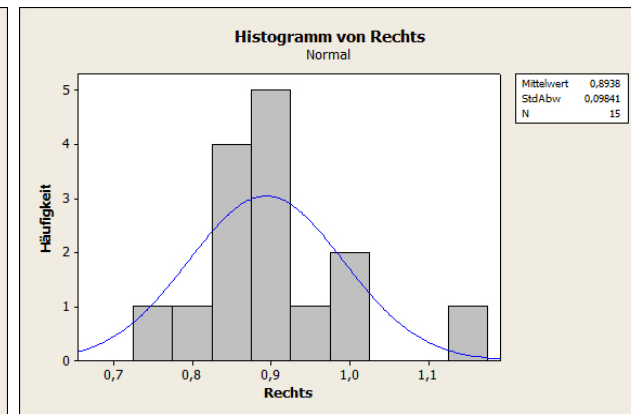
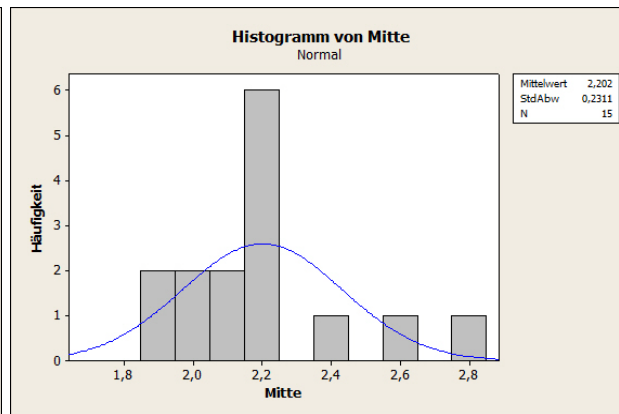
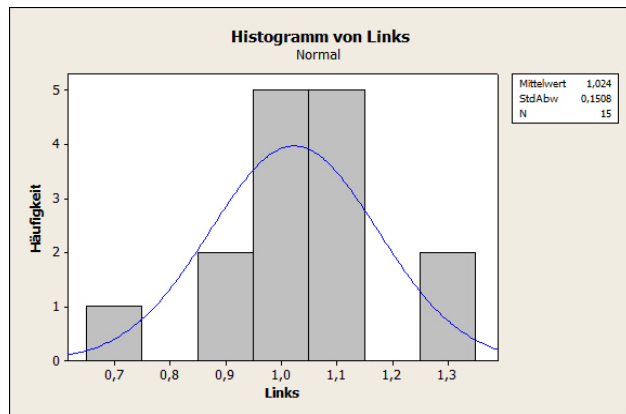
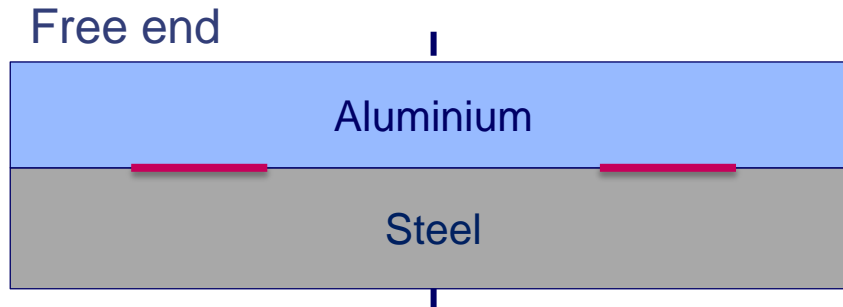
Process window



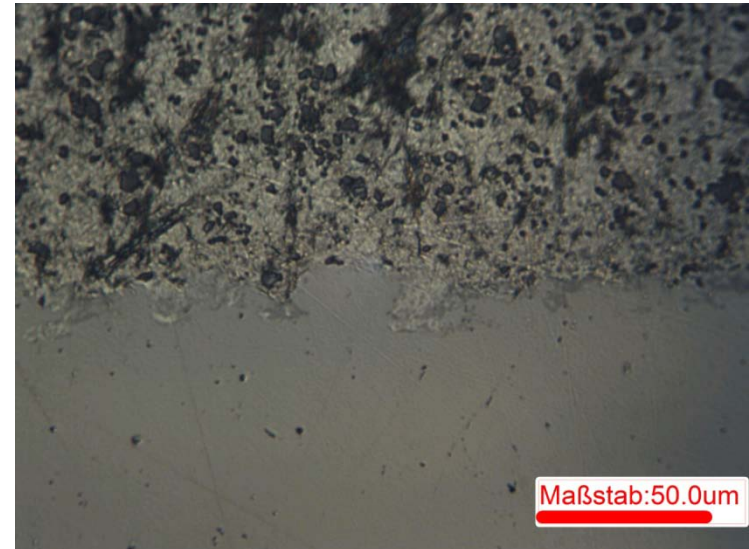
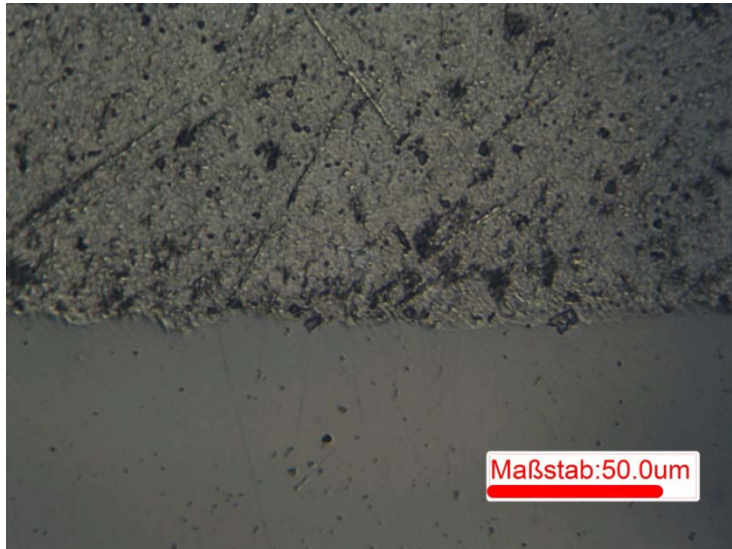
Distribution for weld length values



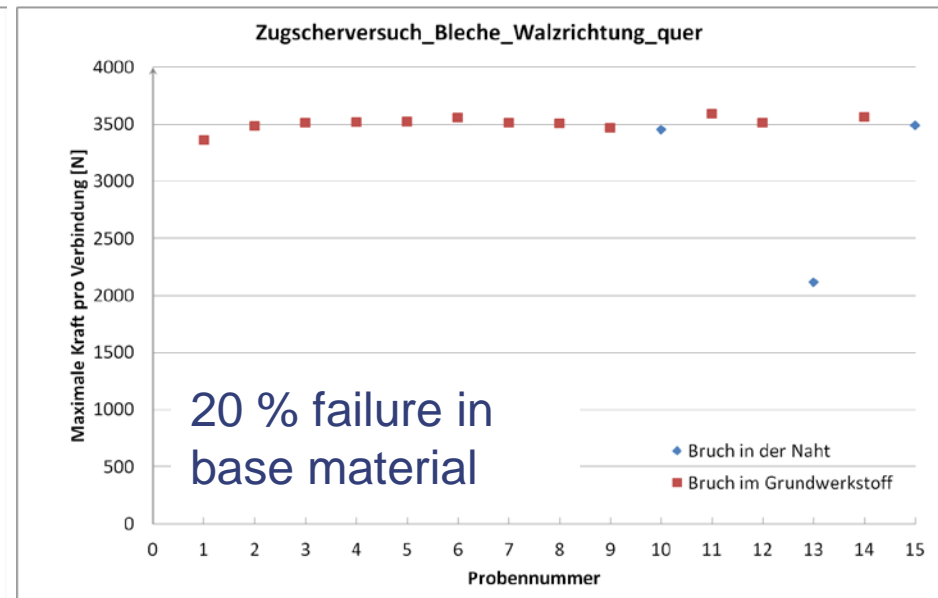
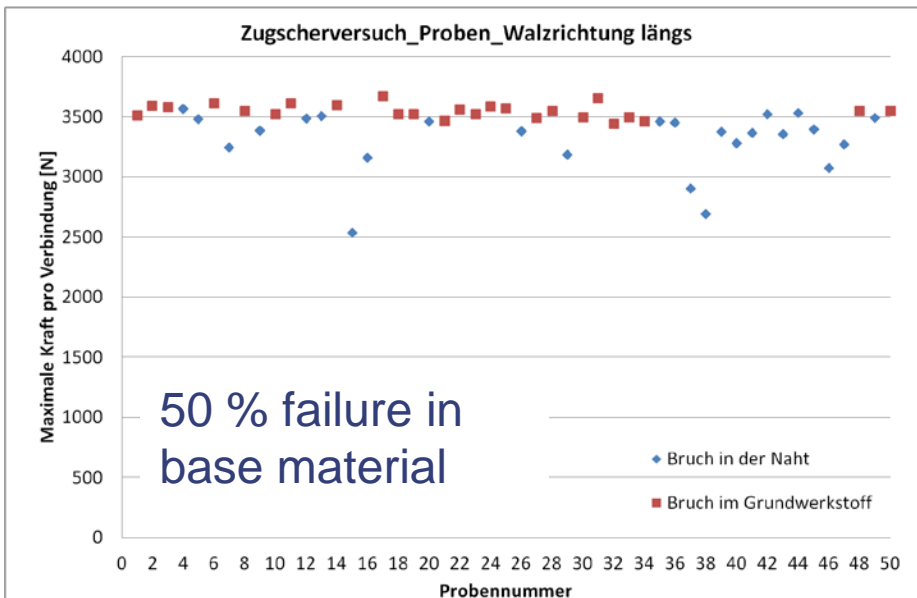
Distribution for weld length values



Comparison of macroscopic appearance

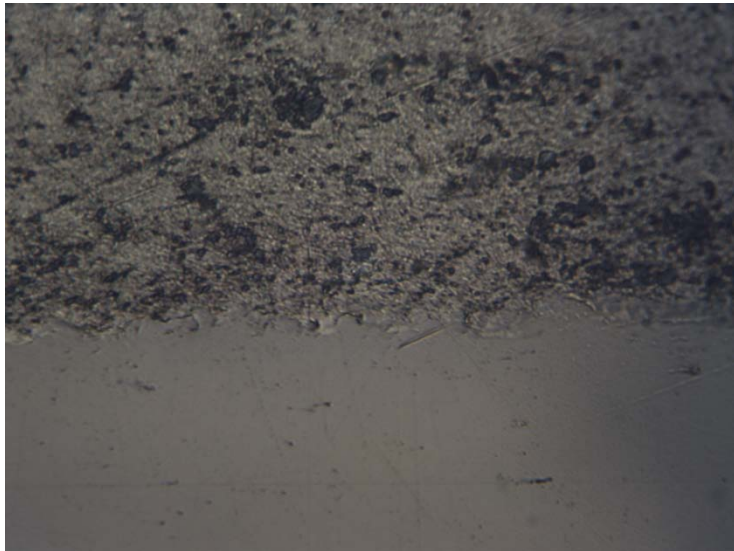


Maximum load per joint

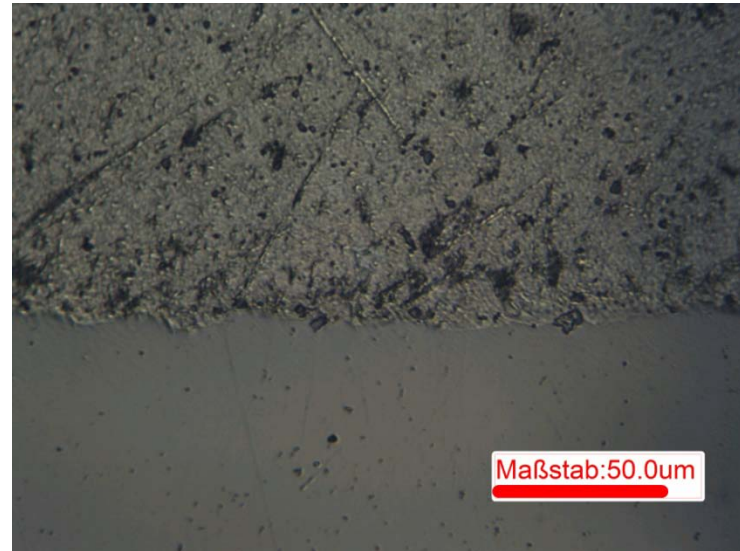


Comparison of macroscopic appearance

Steel
S355
MC



↑
S235



Ongoing work

- Fatigue test for different rolling directions
- Impact of surface conditions on interfacial appearance
- Impact on grain size in interfacial appearance
- Crack formation in MPW under different conditions
- Reproducibility under certain conditions for stiffer Al-alloys
 - Max. load is not linked directly to the appearance of the weld in microscopy

Vielen Dank für Ihre Aufmerksamkeit!

