

# **Weld Quality Study of Projection Nut Welding with Modular Weld Head**

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*Sheet Metal Welding Conference XVIII 2018*  
Welding Solutions for Lightweight Vehicle Production

*October, 2018, Livonia, Michigan*

- Introduction
- Modular weld head
- Weld quality study
  - Microstructure
  - Mechanical properties
  - Electrode life
- Closing Remarks





# Introduction

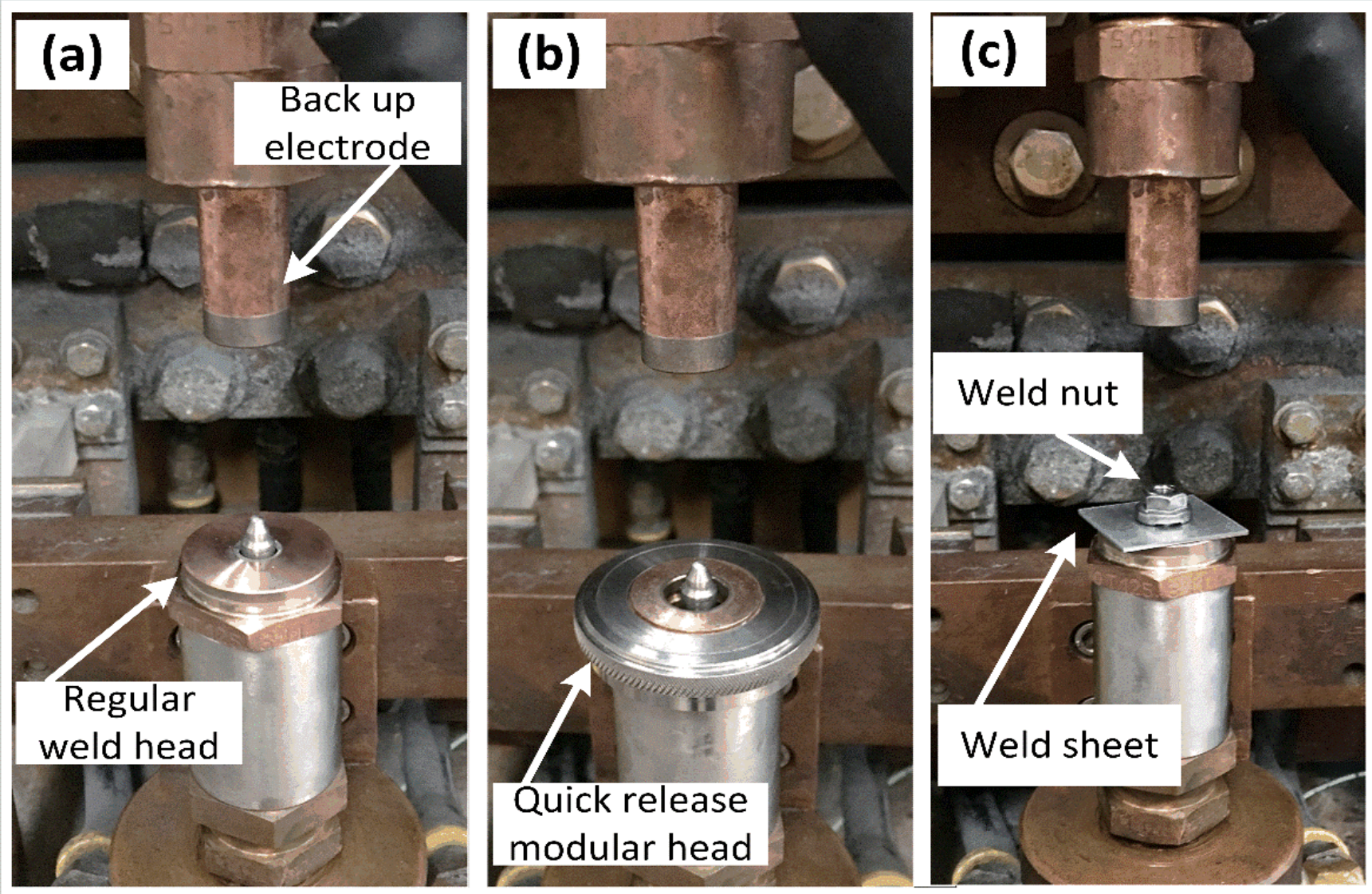
- Resistance projection nut welding is widely used in automotive component assembly
- The quality of the joining of these nuts to the stamped body components is critical for the final product's safety and reliability
- The current flow of projection welding is determined by the contact projections



Video



# Experiment Set Up



# Welding Electrodes



Backup electrode

Upper electrode



Regular weld head

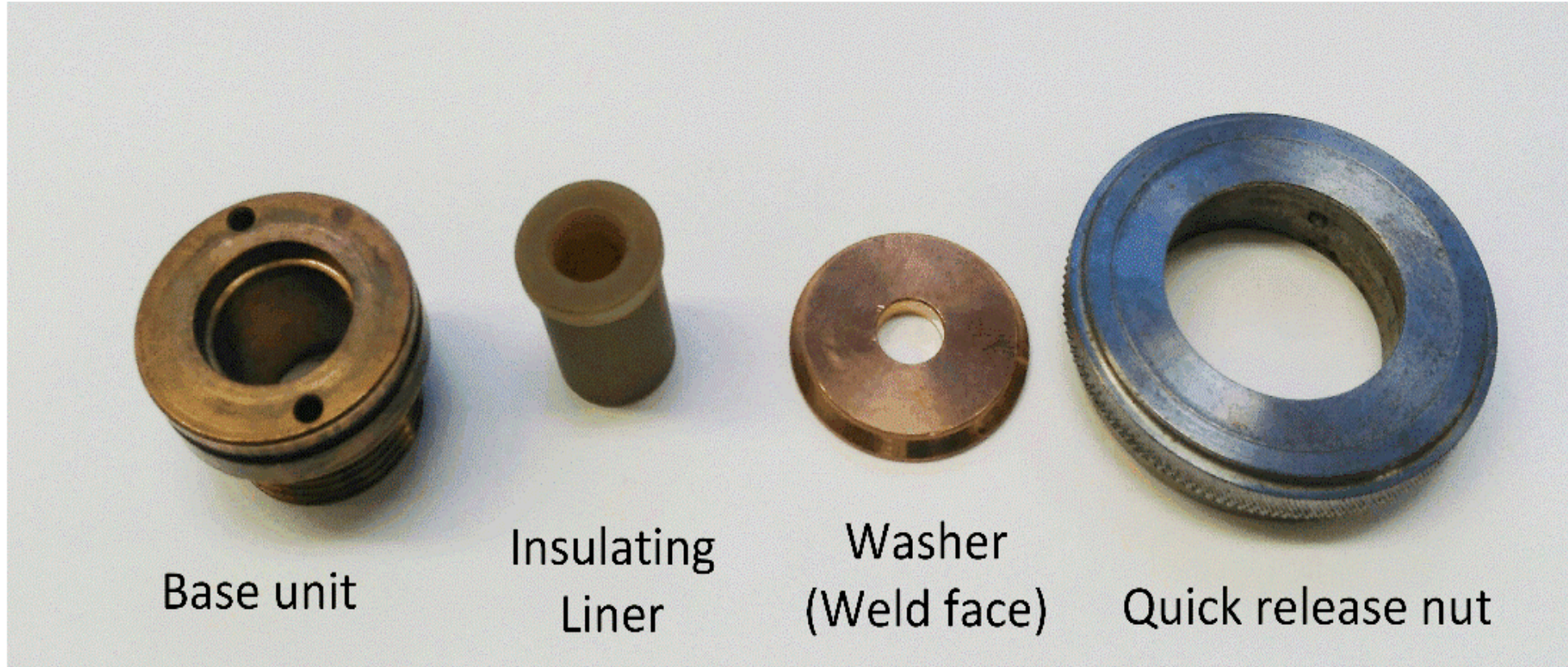
Quick release  
Modular weld head

Lower electrode





# Quick Release Modular Weld Head



Disassembled parts of patent-pending quick release modular weld head

\* Patent Pending

# Modular Weld Head



Disassembled parts of modular weld head



# Cost Analysis

## Regular Head

Replace whole head at the end of electrode life

Manufacturing process involves joining of tungsten copper to the copper base

Approximate electrode life : 10,000

- Weld surface can be re-surfaced, up to 2 times
- Capital cost and set up cost for re-surfacing
- Electrode height changed after re-surfacing
- Position setup or adding copper shims required

For 600,000 welds:

- Need 20 weld heads=\$700
- Re-surface each head 2 times (Total 40 times)
- 40 hours labor for resurface and set up @\$75/hour

Total is \$3,700

## Modular Head

Replace the washer at the end of electrode life

Individual parts are mechanically assembled

Approximate electrode life : 10,000

- No need to resurface the washer
- Electrode height will always be the same

For 600,000 welds:

- Need 60 washers=\$360
- Need 30 liners=\$195
- Need 6 nuts=\$192\$
- Need 3 bases=\$108

Total is \$855

## Quick-Release Modular Head

Replace the washer at the end of electrode life

Individual parts are mechanically assembled

Approximate electrode life : 10,000

- No need to resurface the washer
- Electrode height will always be the same

For 600,000 welds:

- Need 60 washers=\$360
- Need 30 liners=\$195
- Need 1 nuts=\$75
- Need 1 base=\$50

Total is \$680

>> Cost 4 times more >>

>>





# Material Properties

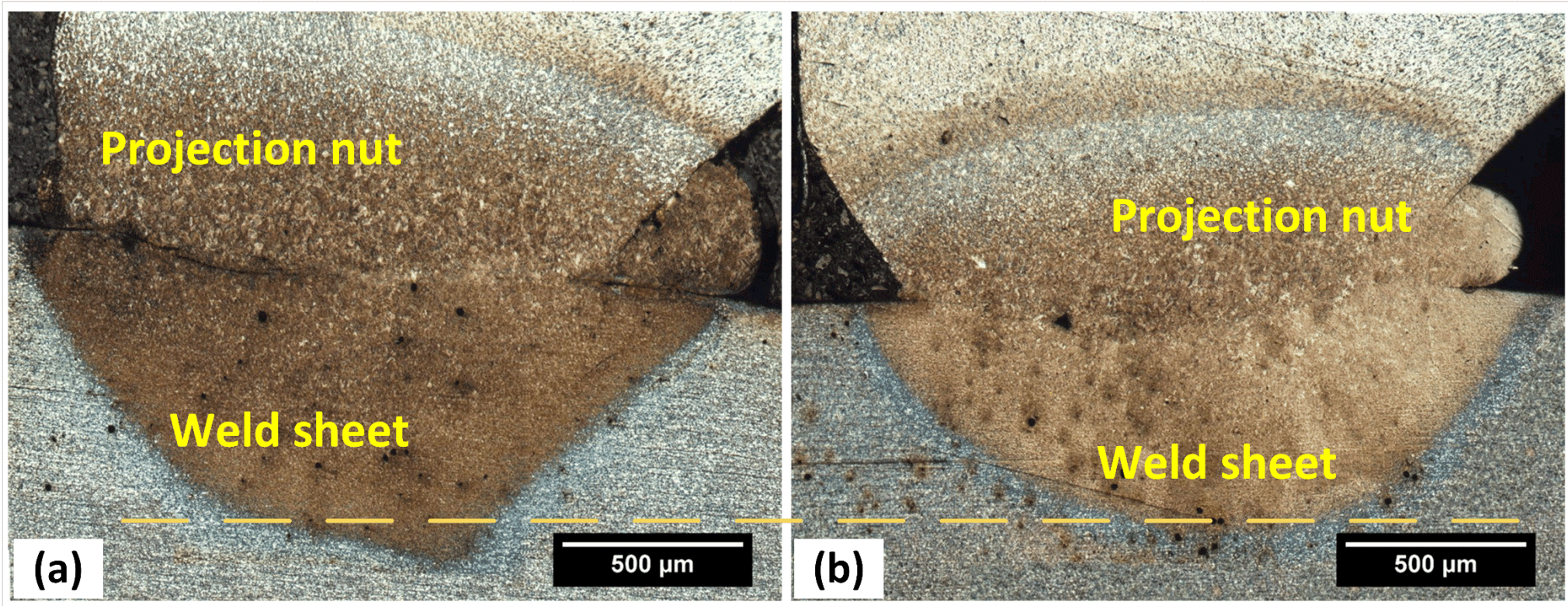
Weld head	Weld face material	Hardness	Electrical conductivity
Regular Head	Tungsten copper class 11 ELKONITE	HRB 98	45% IACS
Modular Head	Class 3 copper C18000	HRB 94	48% IACS min

## Material properties of weld faces

**Weld Sheet:** 1mm thick GI coated DP600

**Weld Nut:** 3-projection hex-flanged M6 weld nuts

**Welding Machine:** 250 kVA, 60Hz single phase AC RSW machine

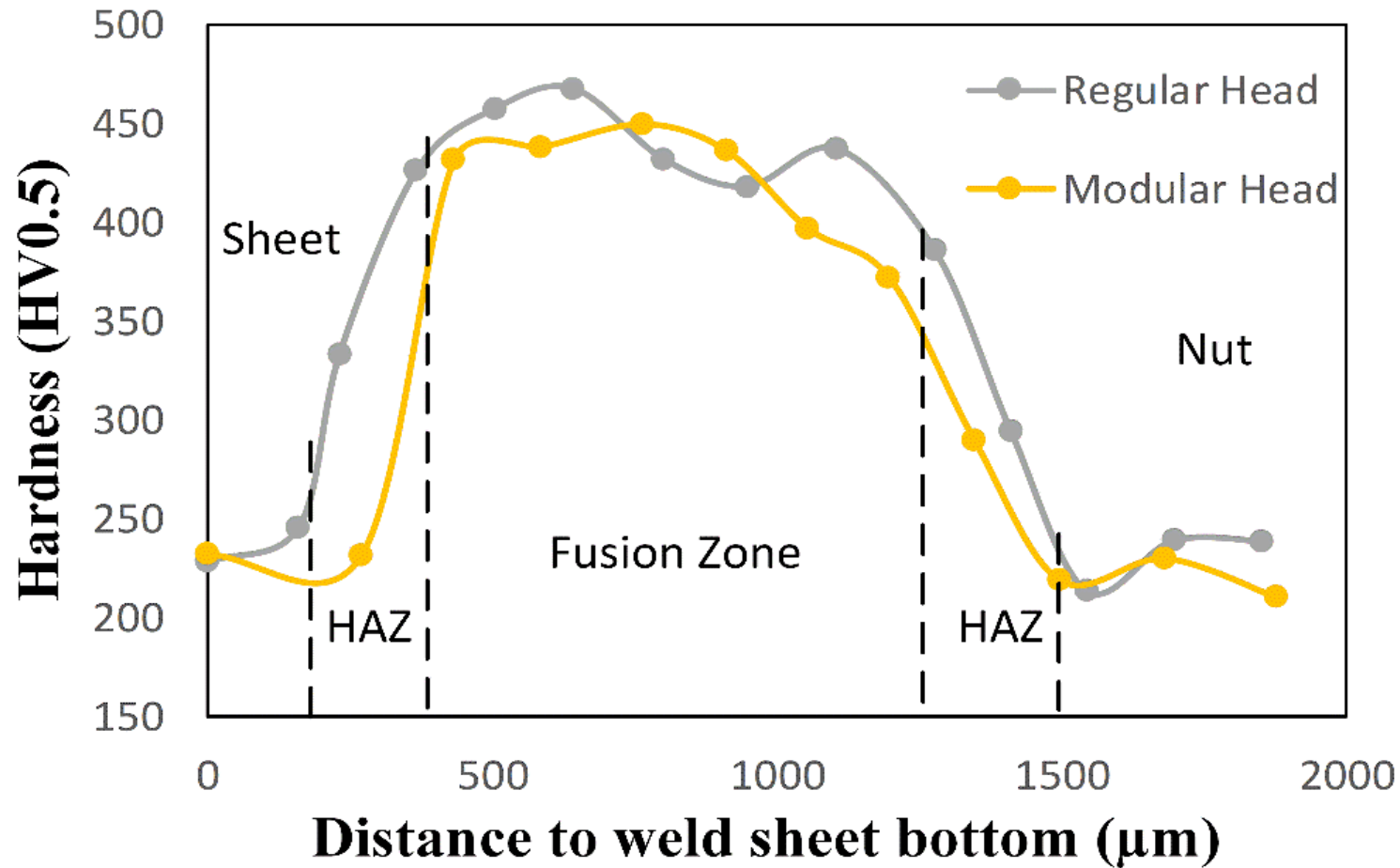


(a) with regular head

(b) with modular head

Optical microscope images of the projection welds after etching

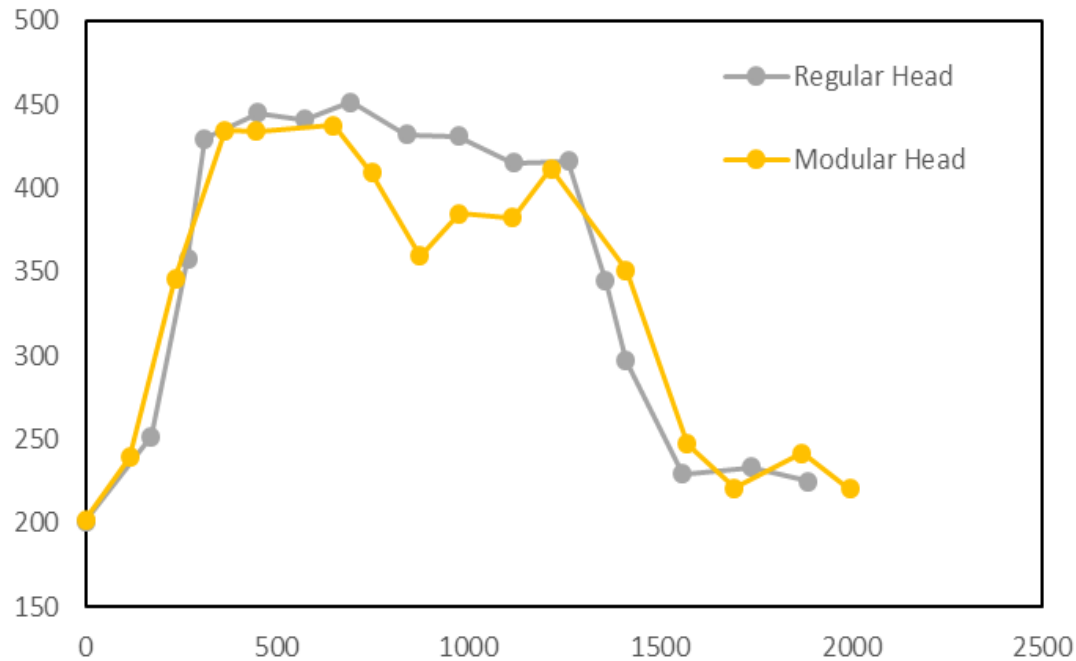
# Hardness Test



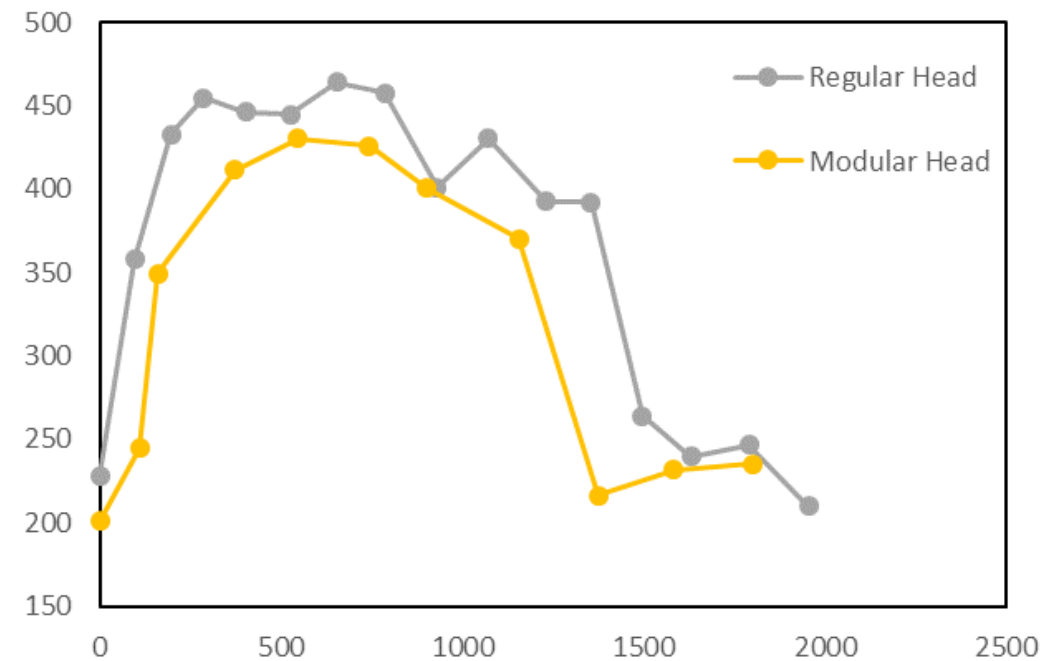
Microhardness of the projection welded sample with different weld heads



# Hardness Test



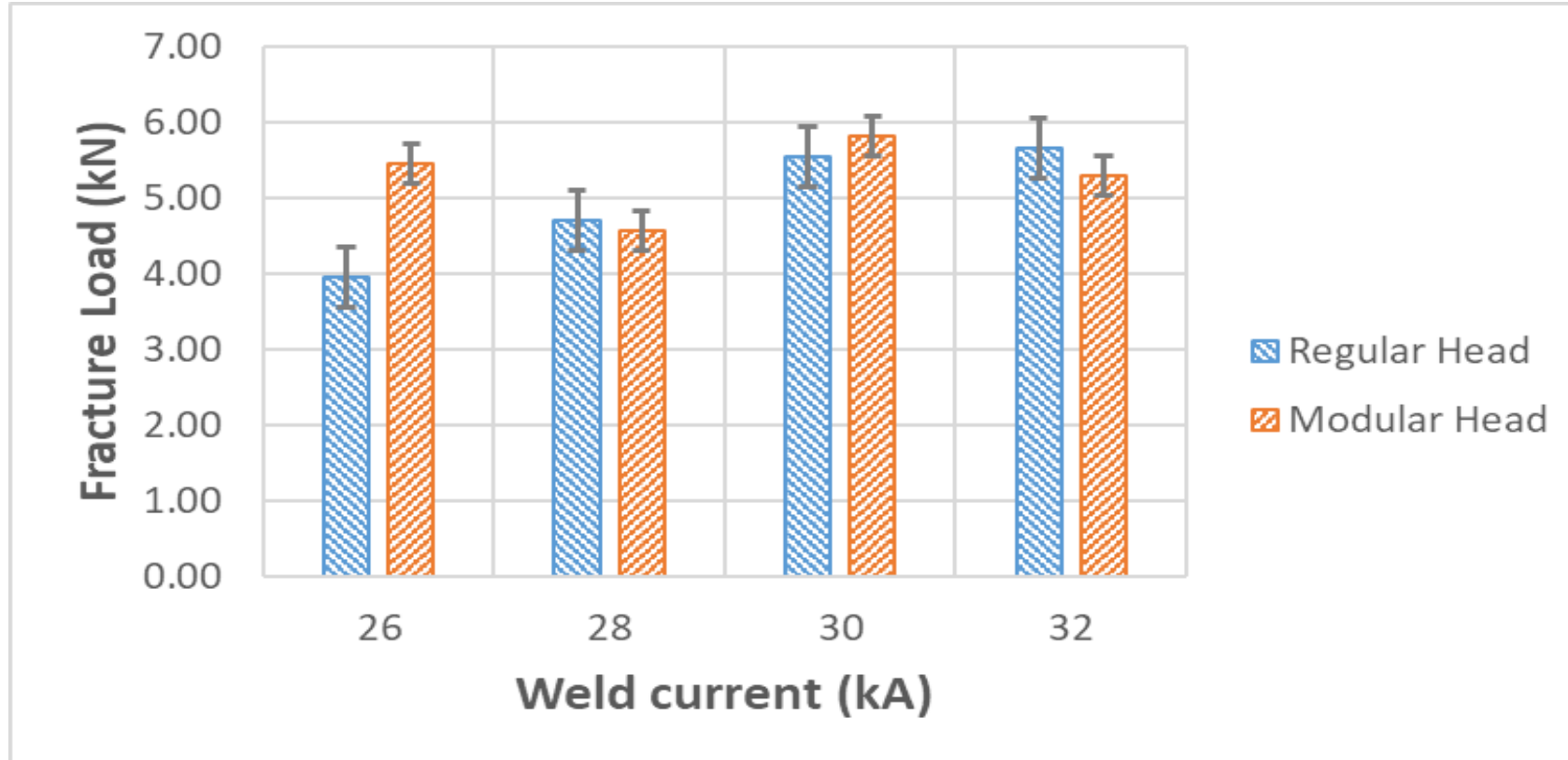
26kA



30kA

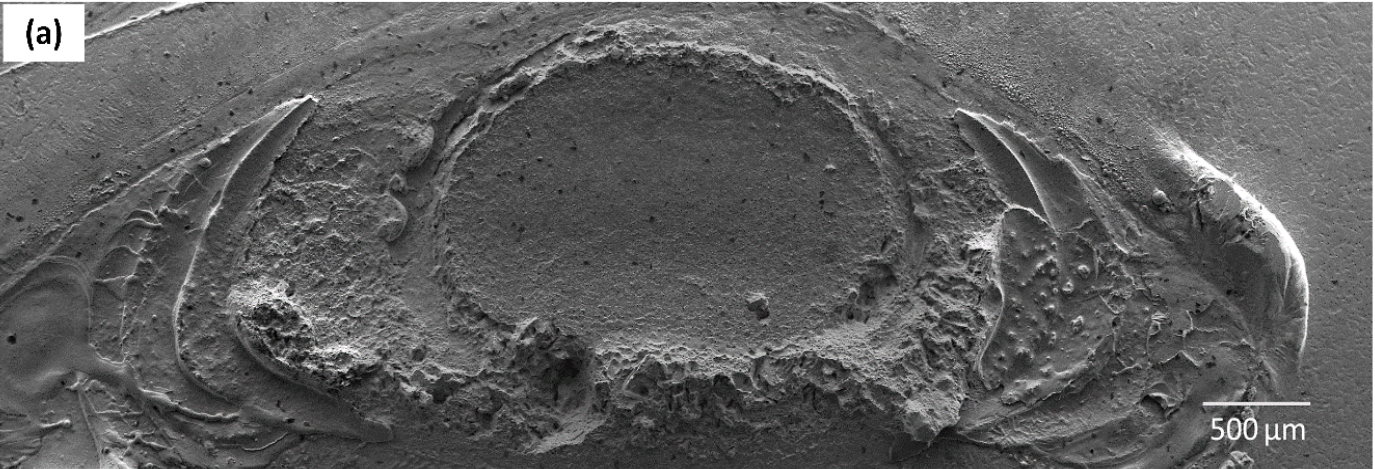
Microhardness of the projection welded sample with different weld heads

# Tensile Testing

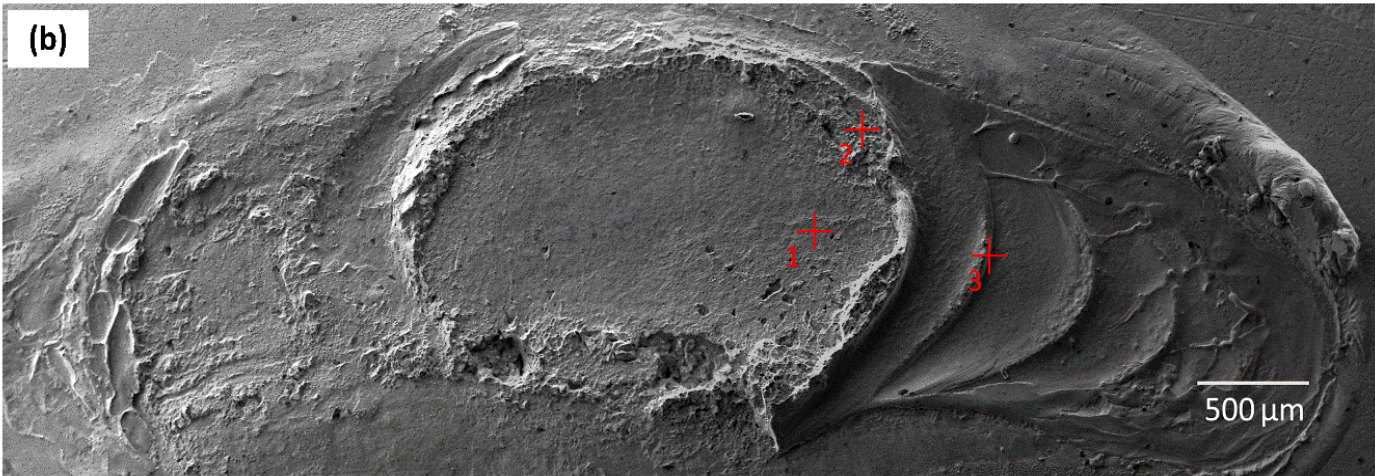


Variation of fracture load with weld current

# Fracture Surface



With regular head



(c)

Element	Fe	Mn	Zn
Spot 1	95.84	1.32	2.83
Spot 2	92.70	1.08	6.22
Spot 3	2.34	-	97.66

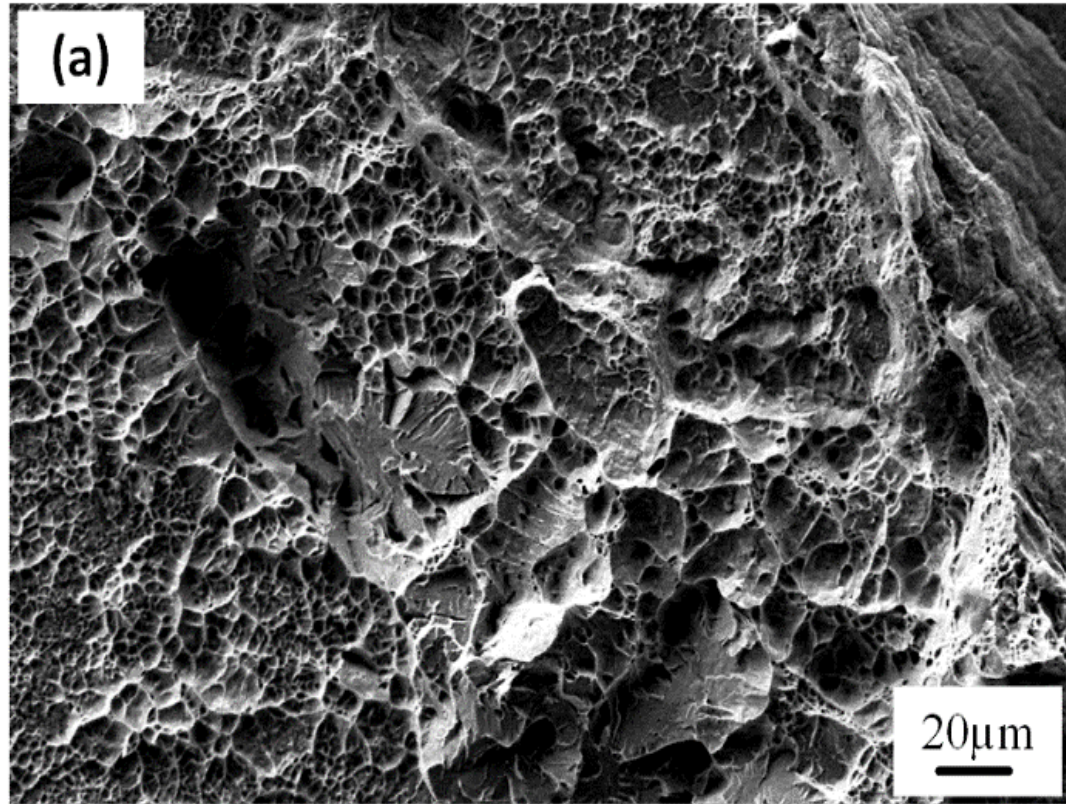
EDX results

With modular head

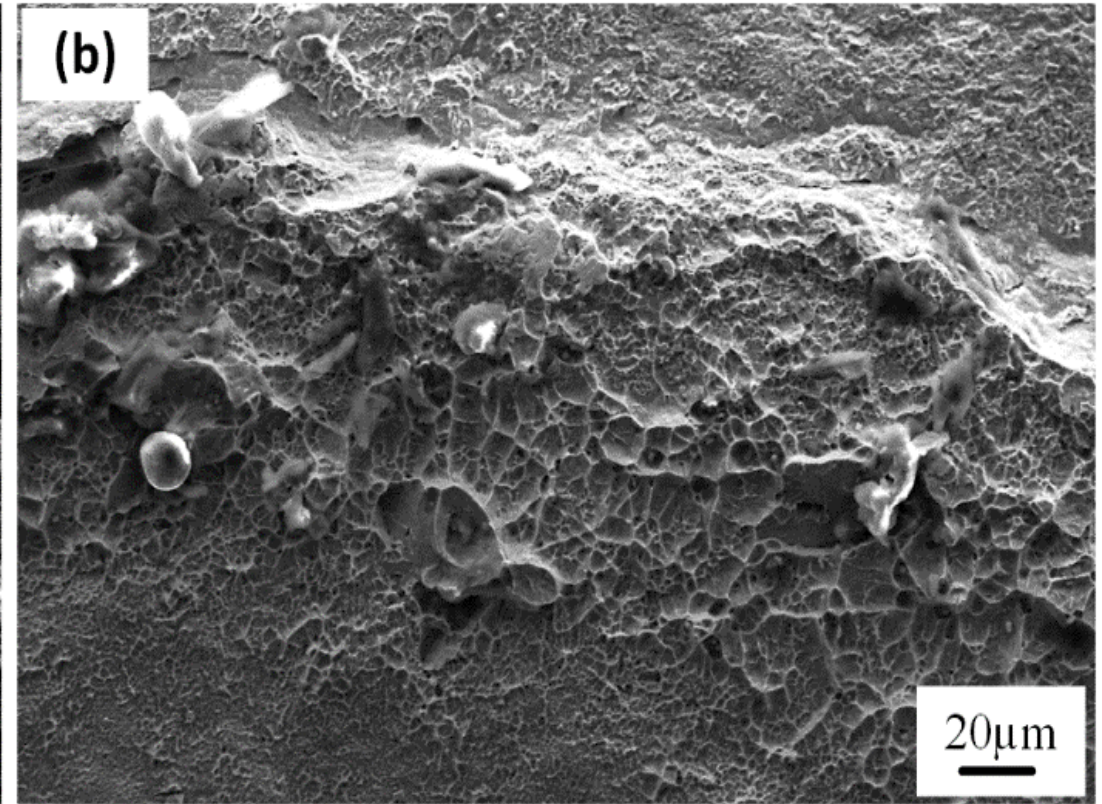
Fracture surface of the projection welds



# Fracture Surface



(a) with regular head



(b) with modular head

High magnification SEM images of the fracture surface

# Electrode Life for Projection Nut Welding

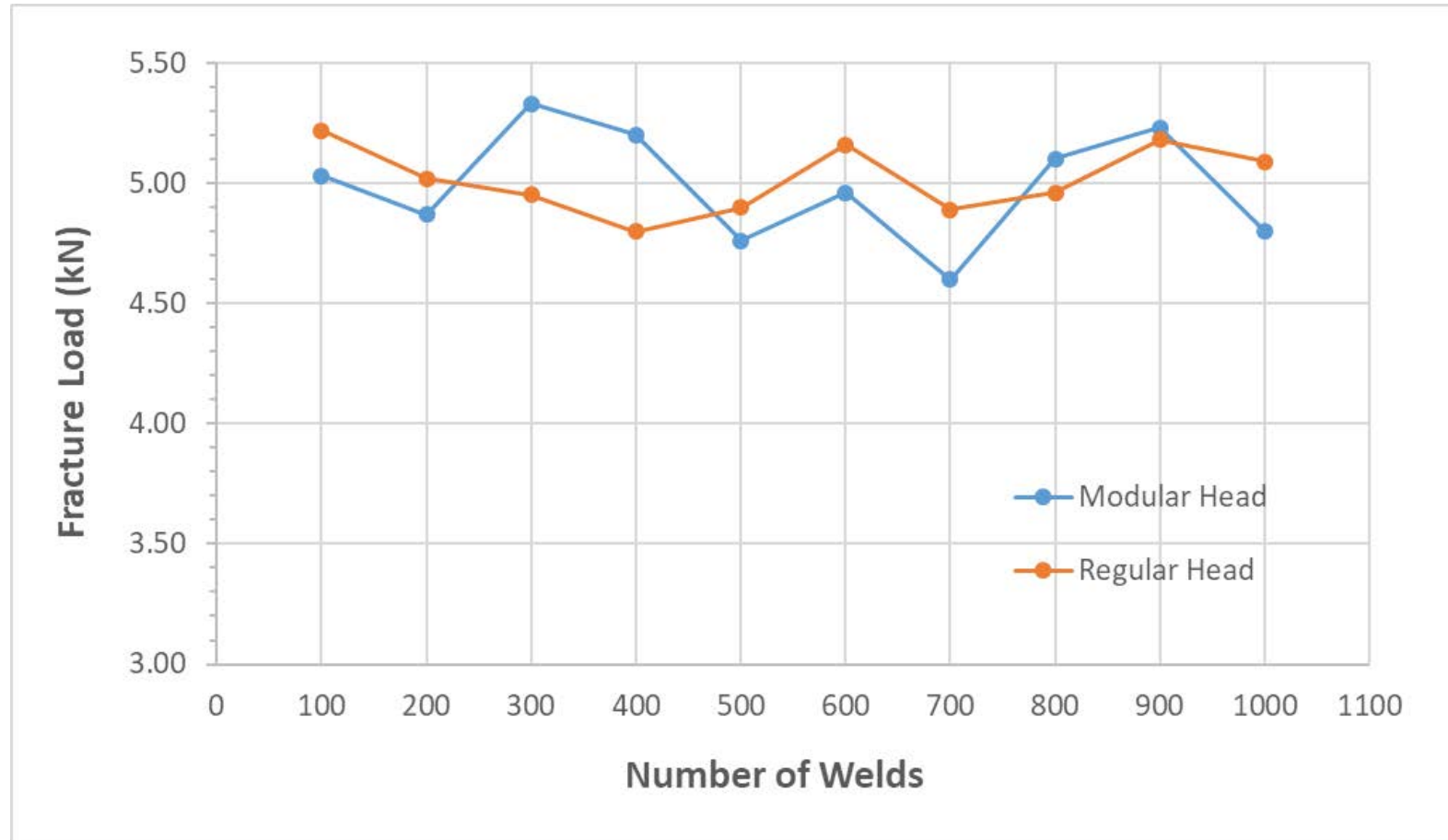


There are no standards, or references about electrode life test for projection nut welding by now

## Approaches to evaluating electrode life

- Tensile test
- Weld thickness
- Weld hardness
- Torque

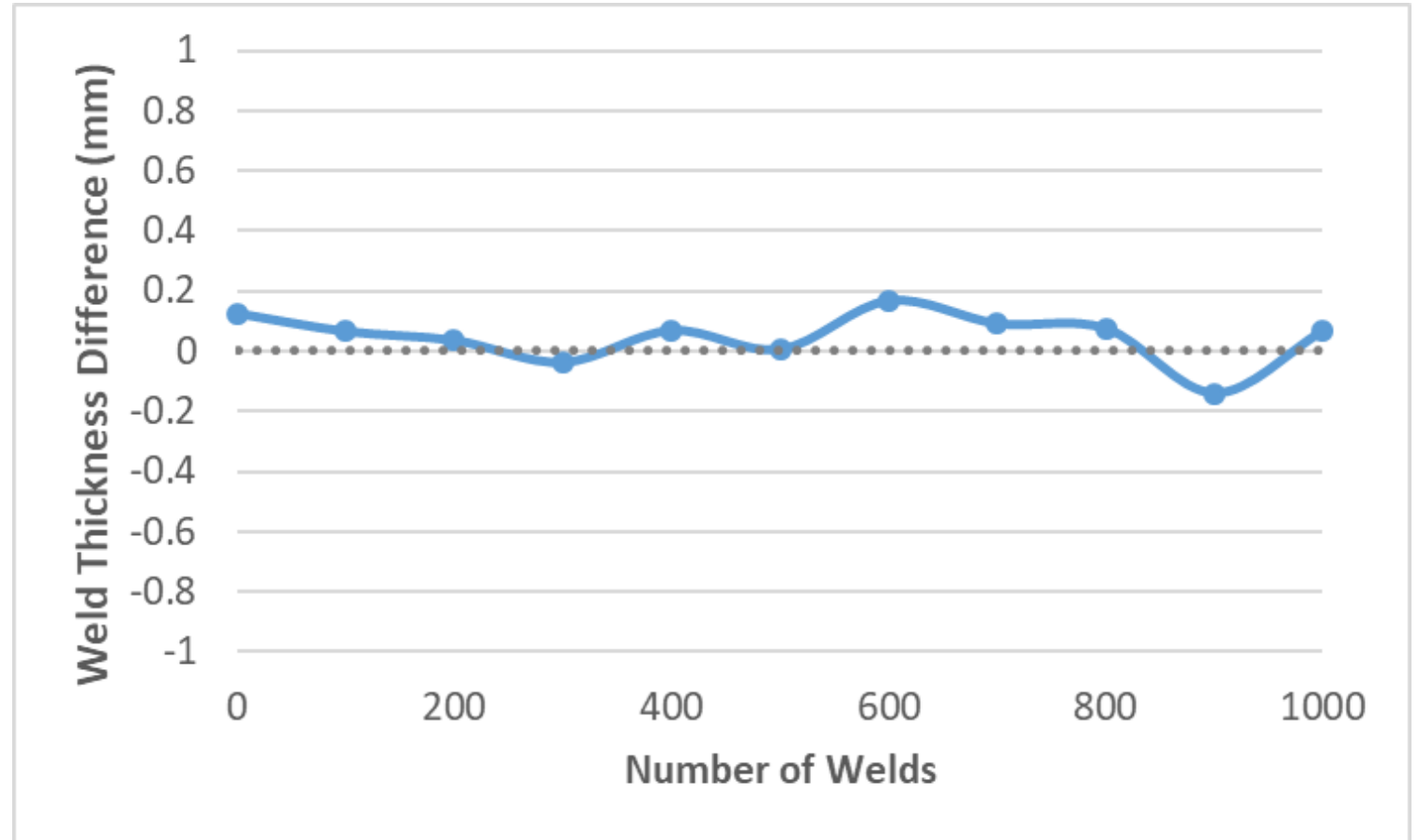
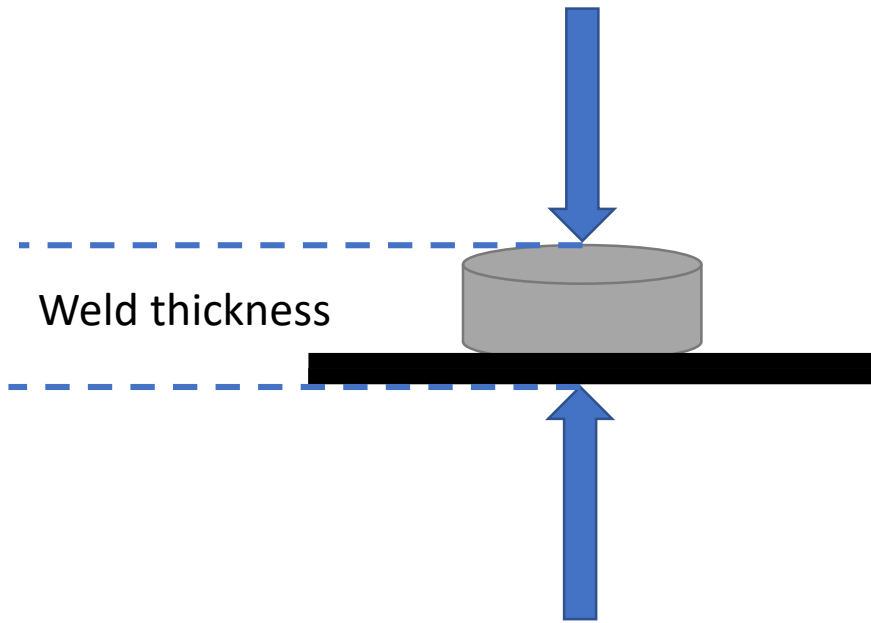
# Electrode Life – Fracture Load



Variation of weld thickness difference between regular head and modular head



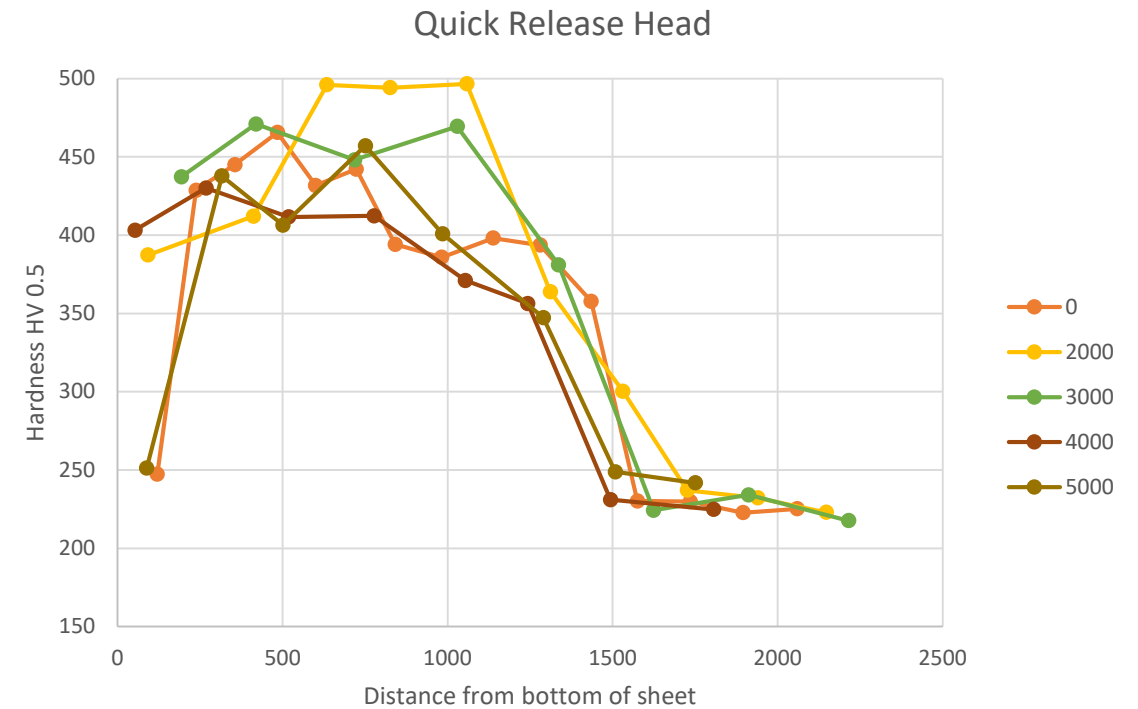
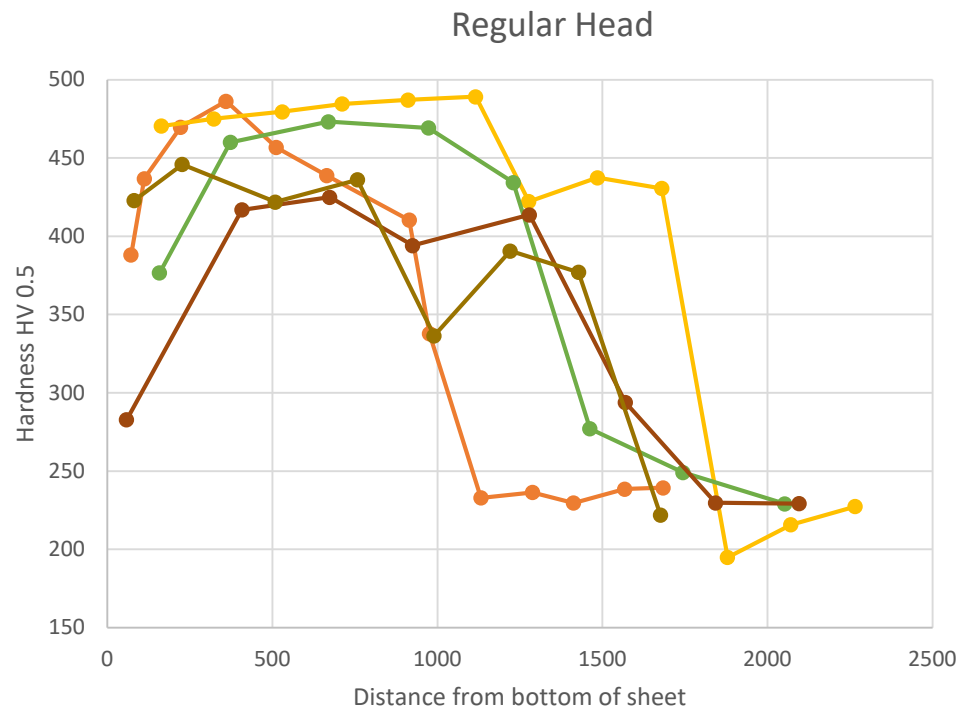
# Electrode Life – Weld Thickness



Variation of weld thickness difference between regular head and modular head

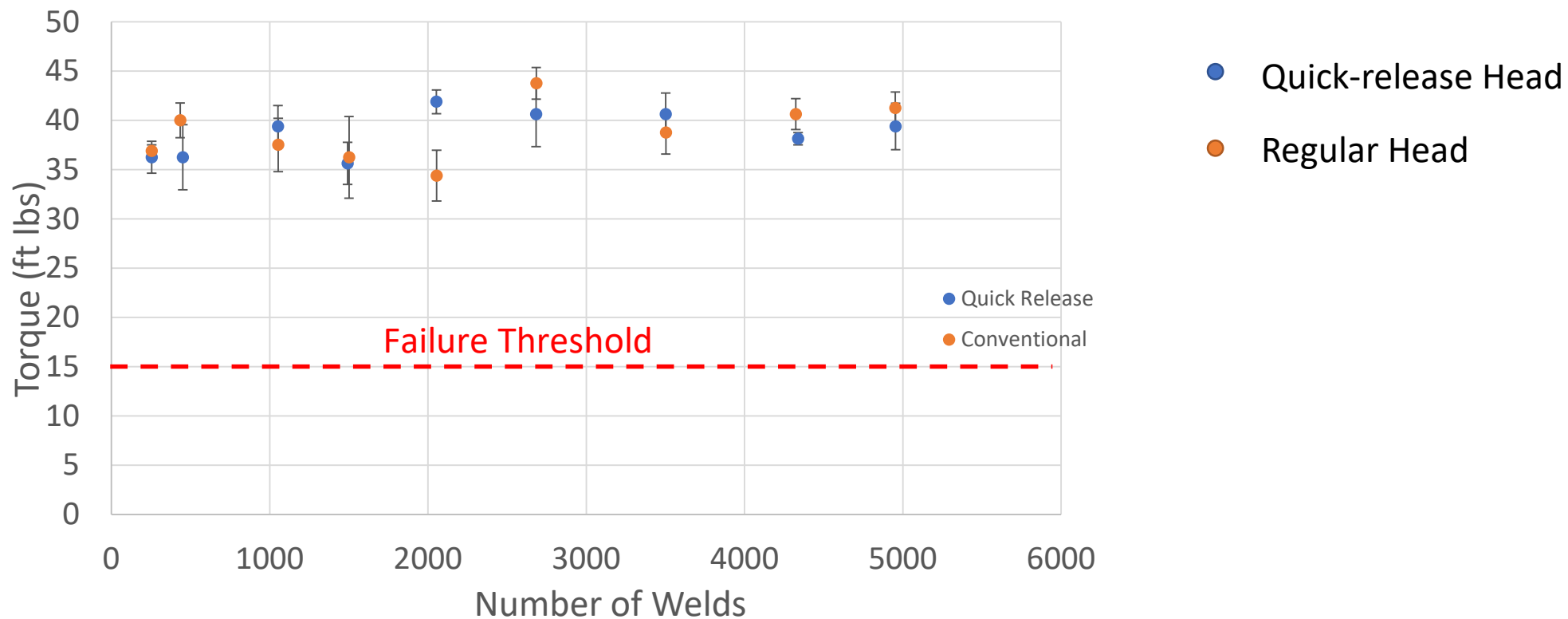


# Electrode Life – Weld Hardness





# Electrode Life – Torque



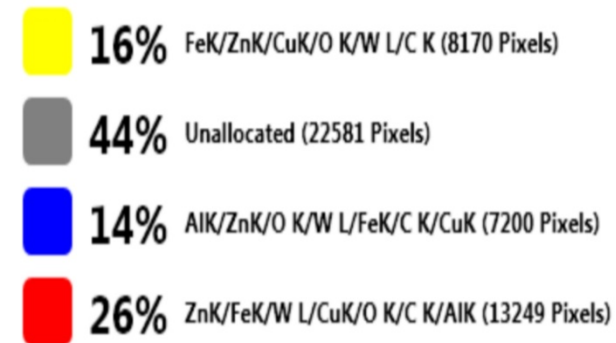
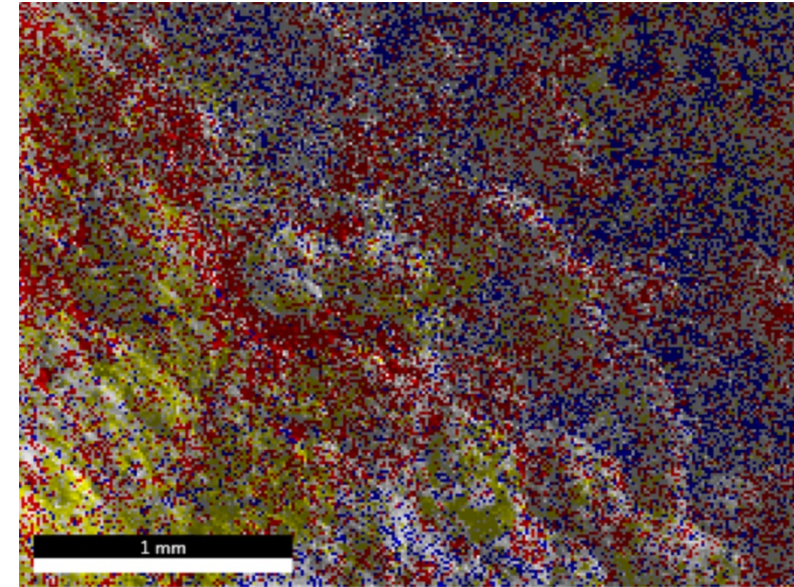
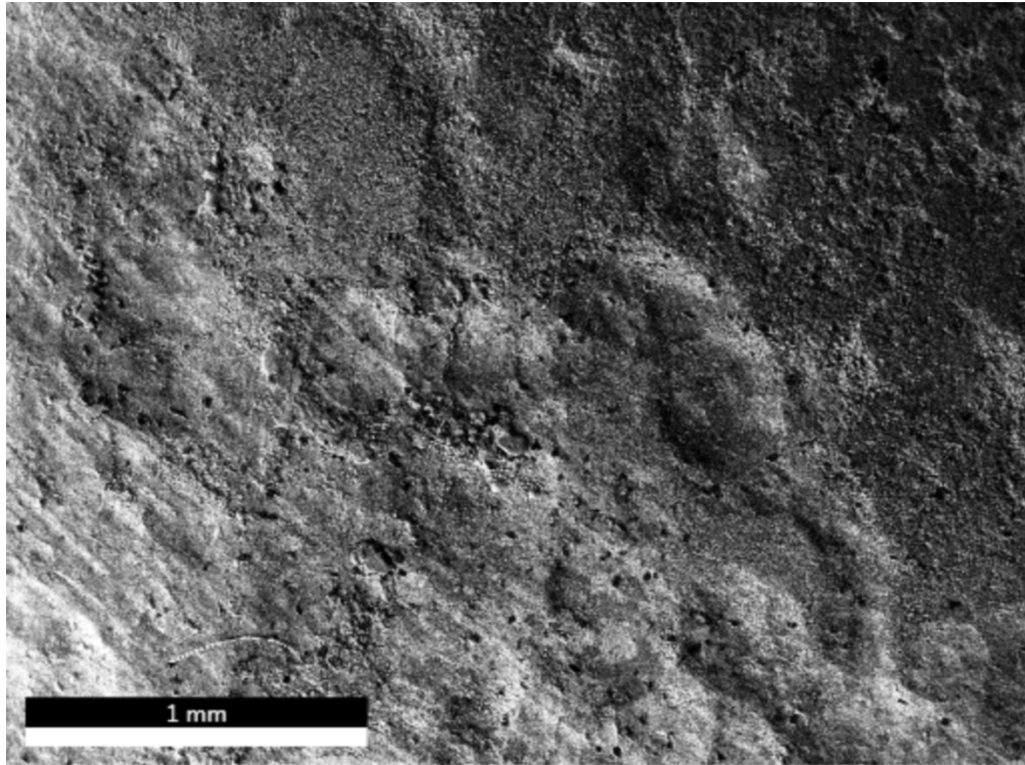
TWI Guidelines:

Nut size	Electrode force, kN	Weld time, cycles	Approximate welding current, kA	Typical minimum torque to failure, Nm
M5	3.6	5	9	12
M6	4.2	6	10.5	20
M8	4.9	9	17	50



# Electrode Life – Wear of Weld Face

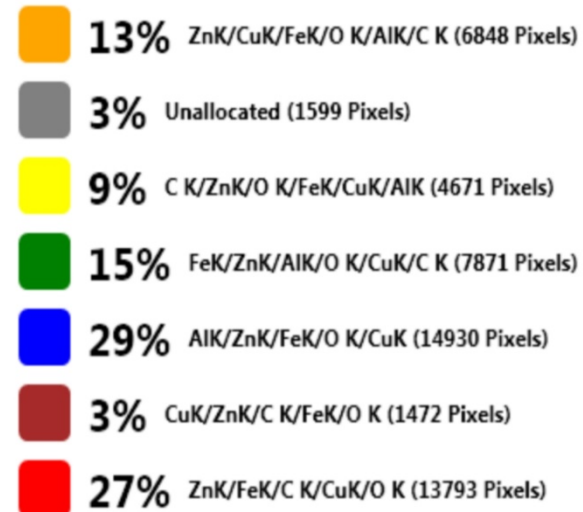
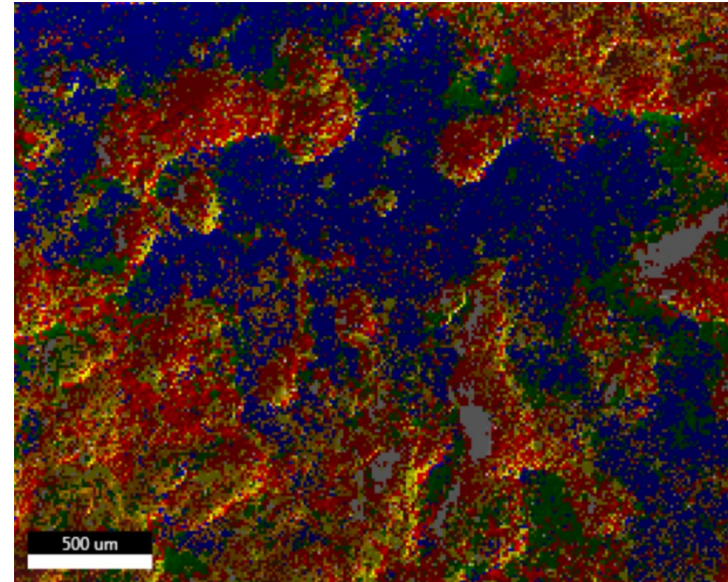
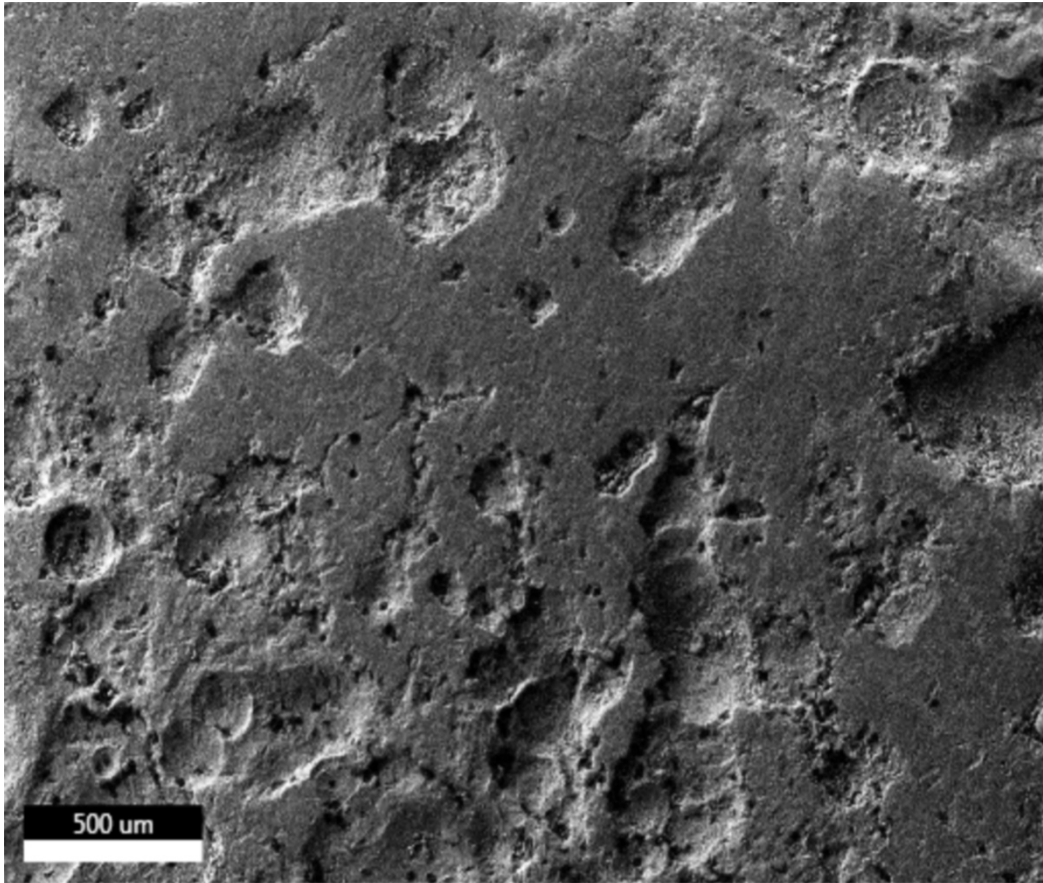
Tungsten copper weld face on regular head weld  
5,000 weld





# Electrode Life – Wear of Weld Face

Class 3 copper weld face on modular head weld  
5,000 weld





# Closing Remarks

- Both weld heads produced good quality welds between the nut and DP600 steel sheet.
- The welds created with a modular head exhibited a slightly thinner heat affected zone due to the better conductivity of the Class 3 copper weld face.
- Tensile testing results indicate that the welds made with both heads had very similar ultimate. The fracture surface from both welds exhibited a ductile fracture mode.
- The life test results indicate that the overall weld life of both weld head types was found to be similar.







Thanks