Metkon Application Note

Preparation of welded Pressure Sensor samples

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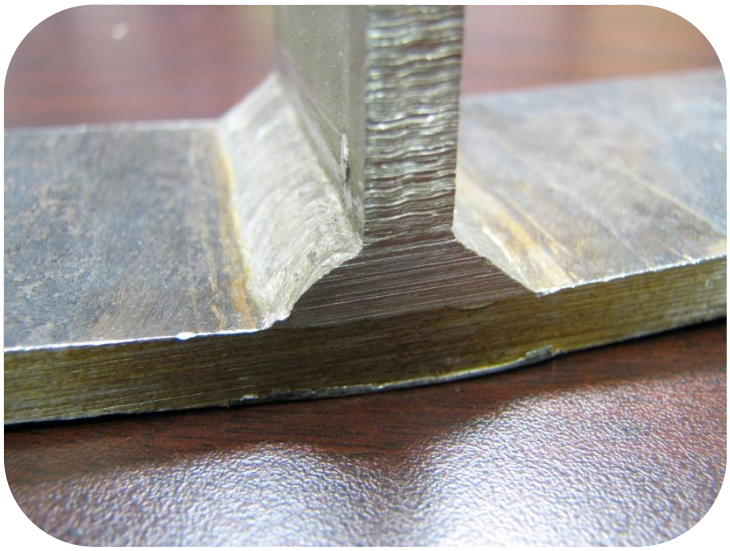
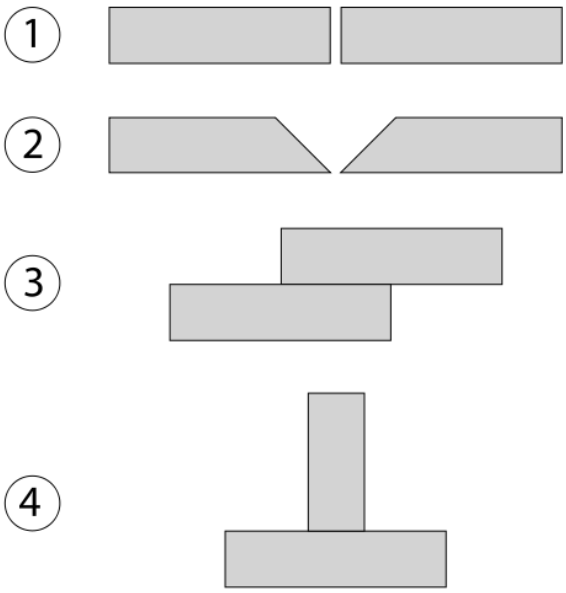
METALLOGRAPHY

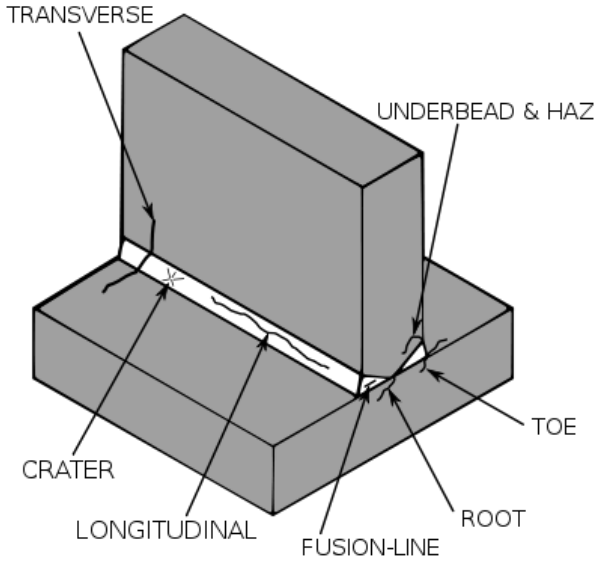
Welding is a fabrication or sculptural process that joins materials, usually metals or thermoplastics, by causing coalescence. This is often done by melting the workpieces and adding a filler material to form a pool of molten material (the weld pool) that cools to become a strong joint, with pressure sometimes used in conjunction with heat, or by itself, to produce the weld. This is in contrast with soldering and brazing, which involve melting a lower-melting-point material between the workpieces to form a bond between them, without melting the workpieces.





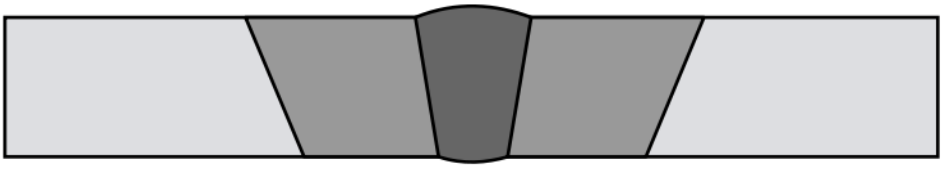
Common welding joint types – (1) Square butt joint, (2) V butt joint, (3) Lap joint, (4) T-joint

Welds can be geometrically prepared in many different ways. The five basic types of weld joints are the butt joint, lap joint, corner joint, edge joint, and T-joint. Other variations exist as well—for example, double-V preparation joints are characterized by the two pieces of material each tapering to a single center point at one-half their height. Single-U and double-U preparation joints are also fairly common—instead of having straight edges like the single-V and double-V preparation joints, they are curved, forming the shape of a U. Lap joints are also commonly more than two pieces thick—depending on the process used and the thickness of the material, many pieces can be welded together in a lap joint geometry.



After welding, a number of distinct regions can be identified in the weld area. The weld itself is called the fusion zone—more specifically, it is where the filler metal was laid during the welding process.

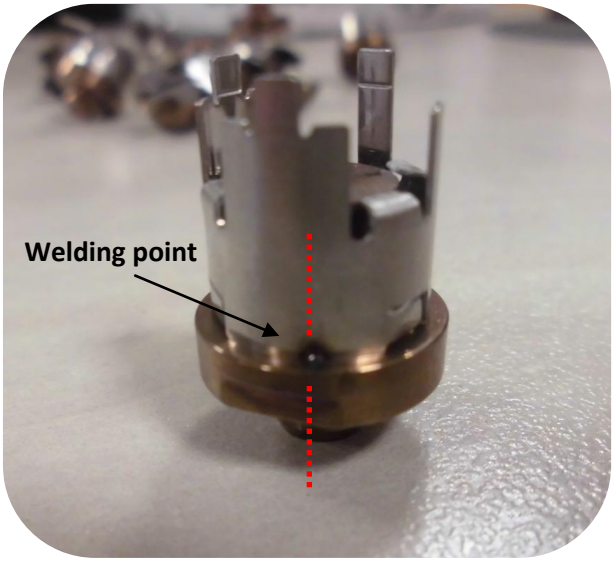
The properties of the fusion zone depend primarily on the filler metal used, and its compatibility with the base materials. It is surrounded by the heat-affected zone, the area that had its microstructure and properties altered by the weld. These properties depend on the base material's behavior when subjected to heat. The metal in this area is often weaker than both the base material and the fusion zone, and is also where residual stresses are found.



The cross-section of a welded butt joint, with the darkest gray representing the weld or fusion zone, the medium gray the heat-affected zone, and the lightest gray the base material.

In this application, welded pressure sensor samples were used which they shown in the picture below.

There are three laser welding points on each sample to be investigated.



Requested cutting line

A. SECTIONING

MICRACUT 201 is built on precisely manufactured heavy duty aluminum frame providing stable and vibration resistant base for precision components and linear bearings. The cutting compartment is fully enclosed.

The transparent hood is equipped with interlocking safety switch. Powerful cutting motor has variable cut-off wheel speeds from 400 up to 5000 rpm allowing both high speed and low speed cutting.
By moving the cutting table, MICRACUT 201 can cut larger and deeper samples. Wide range of clamping tools can be used on the T-slotted moving table. Optional X - axis table with motorized drive mechanism positions the specimen with 5 microns positioning accuracy.

	Order Code	Description
Equipment Used	17 06	MICRACUT 201, PRECISION CUTTER
Clamping Device	GR 0825 GR 0400	Manual X-axis positioning unit Universal specimen vise
Cutting Fluid	19-902	Metcool, Nature Friendly Soluble Oil,5lt.
Cutting Disc	18-200	Treno-HP, Ø 200 mm, for Non ferrous & Stainless Steel

B. MOUNTING

ECOPRESS 100/200 are high capacity, state of the art automatic mounting presses having advanced software with programmable HMI touch screen controls.

Robust bayonet closure allows for quick and safe operation. Wide selection of mould assemblies from 25 to 50 mm in diameter are available. Two mounts can be produced simultaneously with the use of an intermediate ram.

ECOPRESS 200, available with dual cylinder can produce four mounts at a time offering a perfect solution for labs with high specimen throughput.

	Order Code	Description
Equipment Used	25 07	Ecopress 100
Mould Assembly	26 06 - 02	Mould assembly 40 mm diameter
Mounting Powder	29-010	NET, Transparent acrylic powder

C. GRINDING & POLISHING

The FORCIPOL Series of grinding and polishing machines offer practical and economical solutions to your metallographic sample preparation needs.

FORCIMAT is a microprocessor controlled sample mover designed to be used with FORCIPOL grinder / polishers. It is ideal for medium size labs where consistent result is desired.

FORCIPOL instruments can be used for grinding, lapping and polishing with magnetic backed discs and cloths or by quick and simple exchange of wheels. When the number of specimens to be prepared increases, FORCIPOL instruments can be fitted with FORCIMAT automatic head for automation.

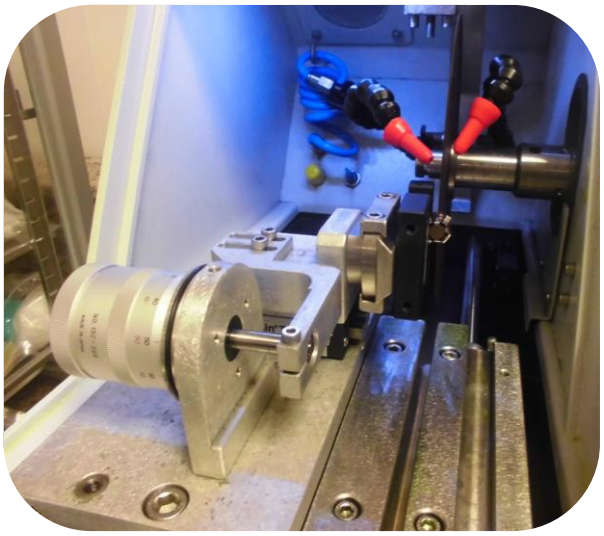
	Order Code	Description
Equipment Used	36 09-250	FORCIPOL 2V
	30 09	FORCIMAT AUTOMATIC HEAD
Equipment Accessories	31 21	PVC Wheel, 250 mm
	31 63	Splash Guard, 250 mm
	39-003-250	Ø 250 mm, Special Magnetic Foil
	39-093-250	Ø 250 mm, Thin Metal Plate(5 pcs)
Sample Holder	33 01	Specimen holder, 6 x Ø40 mm

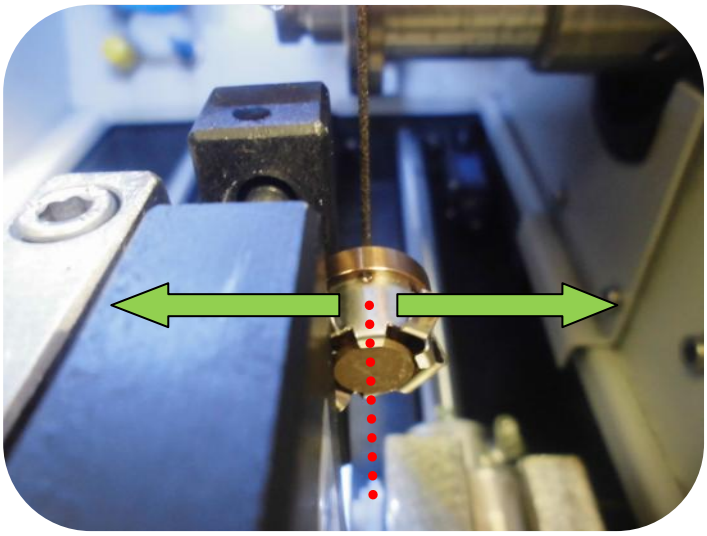
D. MICROSCOPY

BasicMagnifications	: 100x - 1000x
Eyepieces	: WF 10x eyepieces paired (field of view Ø16mm)
Objectives	: 10x/0.25 (W.D. 6.7mm), 25x/0.40 (W.D. 0.76mm) 40x/0.65 (W.D. 0.67mm), 100x/0.25 (oil) (W.D. 0.3mm)
Stage	: Mechanical stage 200 x 152mm travel with right hand Coaxial dropdown controls, movable range 15 x 15mm
Focusing	: Coaxial low position coarse & fine focus controls graduated to 2 microns per division.
Illumination	: 6V 20W adjustable light sources with halogen lamp
Size&Weight	: 540L x 195W x 320H mm & 10kg
Order No	: 60 01

	Order Code	Description
Equipment Used	60 01	IMM 901 Inverted Metallurgical Microscope
Equipment Accessories	66 10	IMAGINE Hardware Set
	66 02	IMAGINE Mesura 200

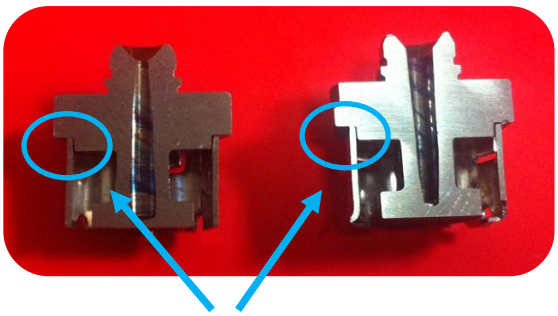
First of all the samples are fixed as it shown in the above photo with the GR 0400 vise.



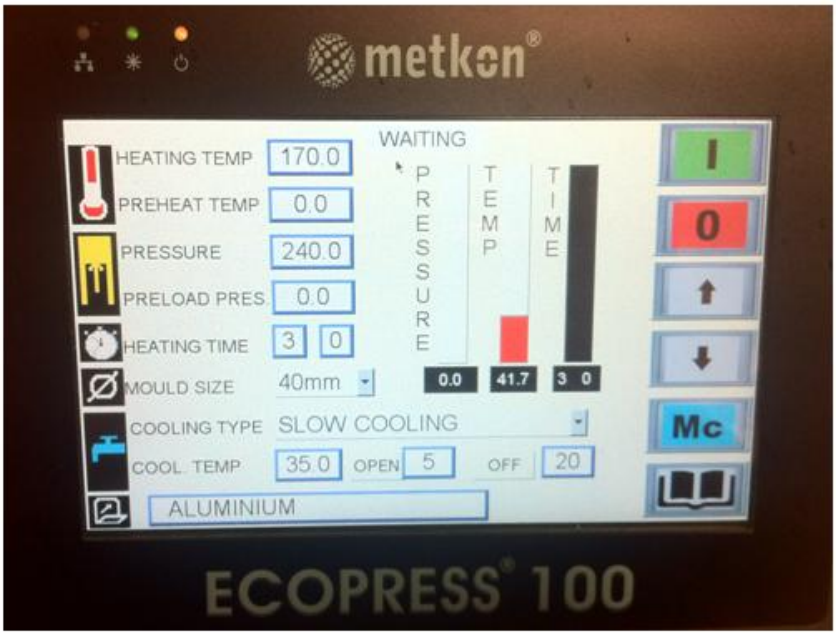


Than specimen vise attached on the Manual X-axis unit. By the help of Manual X-axis unit suitable sample position can be adjusted according to cutting line.

Operation parameters are following;
Feed rate: 200 µ/sec - ***Rpm:*** 2500 - ***Travel:*** 40 mm - ***Force:*** 3A



Specimens divided from three different welding points which shown as above photos.



After that divided specimens mounted with ECOPRESS 100 hot mounting machine. Operation parameters are shown as above picture.

Finally specimens are grinded & polished with FORCIPOL 2V + FORCIMAT equipment.

Operation parameters are following;

	Surface	*Abrasive*	*Lubricant*	*Force per sample(N)*	*Time(min.)*	*Disk speed(rpm)*	*Head speed(rpm)*
Grind. Step 1	*DEMPAX* [38-040-600]	600 grit SiC	Water	20 N	1 min.	200	*100*
Grind. Step 2	*DEMPAX* [38-040-1200]	1200 grit SiC	Water	25 N	2 min.	200	*100*
Polishing Step	FEDO-3 cloth [39-025-250]	*3µ diamond susp.* [39-420-M]	*DIAPAT* [39-502]	25N	3 min.	200	*100*

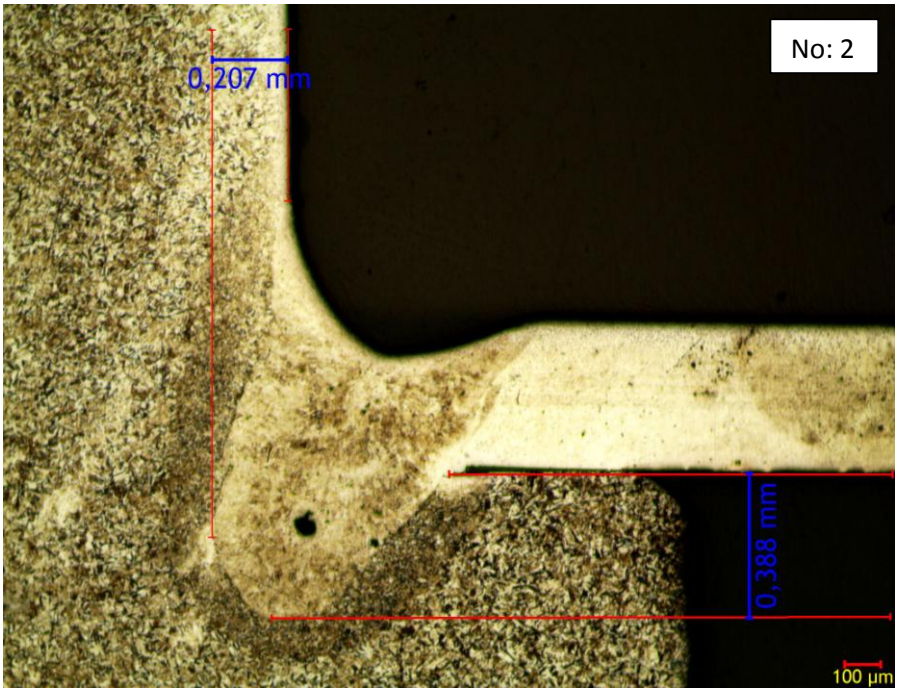
After polishing operation the sample etched Kalling's No. 2 solution to see heat-affected zone.

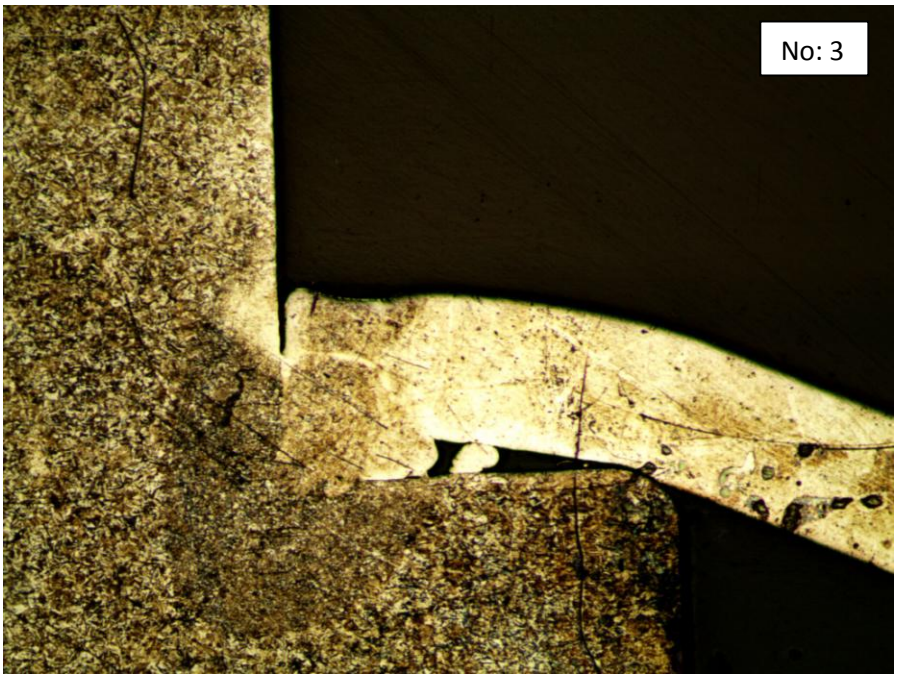
RESULT

As a result welded pressure sensor samples were subjected to the following operations;

Cutting → Mounting → Grinding → Polishing → Etching → Microscopic determination

Microstructure images of specimens following for different welding zones.





Welding area, heat-affected zone and base material microstructure can be seen above images.

24.12.2013 – METKON LAB