Metkon Application Note

Preparation of Induction-Hardened Steel Part

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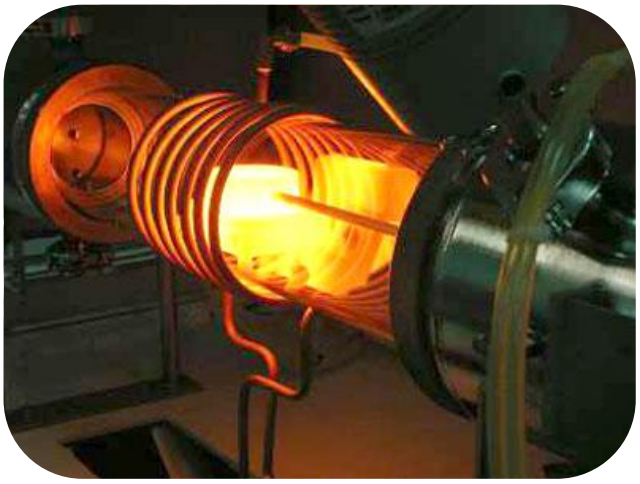
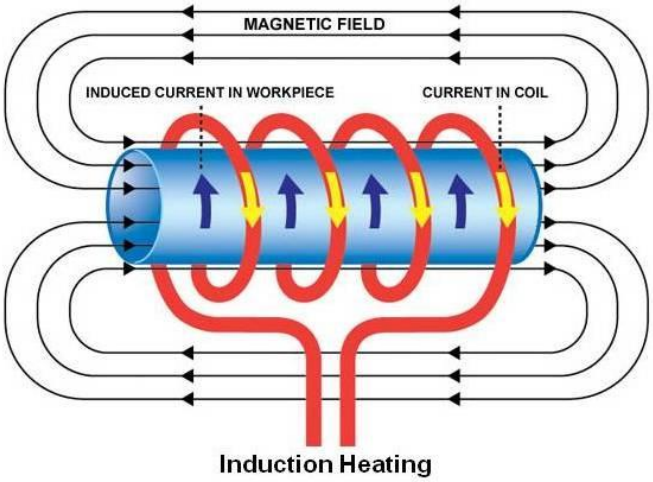
metkon
Technology behind Specimen

INTRODUCTION

Induction hardening is a form of heat treatment in which a metal part is heated by induction heating and then quenched. The quenched metal undergoes amartensitic transformation, increasing the hardness and brittleness of the part. Induction hardening is used to selectively harden areas of a part or assembly without affecting the properties of the part as a whole.

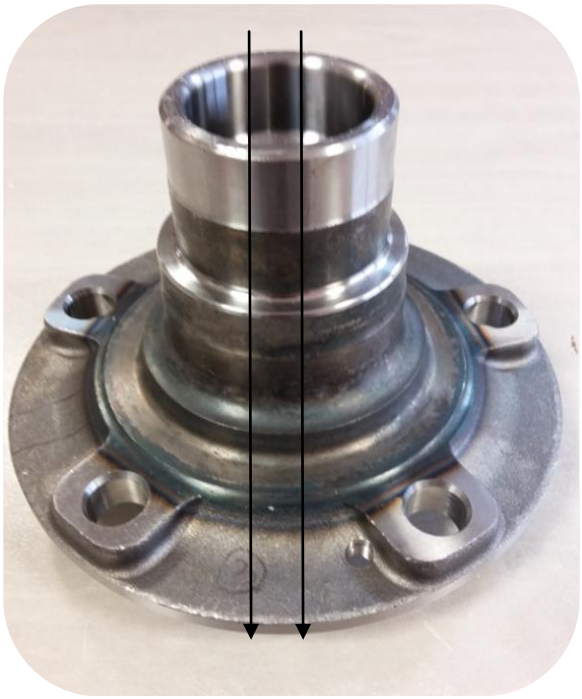
Induction heating is a non contact heating process which utilises the principle of electromagnetic induction to produce heat inside the surface layer of a work-piece. By placing a conductive material into a strong alternating magnetic field, electrical current can be made to flow in the material thereby creating heat due to the I2R losses in the material. In magnetic materials, further heat is generated below the curie point due to hysteresis losses. The current generated flows predominantly in the surface layer, the depth of this layer being dictated by the frequency of the alternating field, the surface power density, the permeability of the material, the heat time and the diameter of the bar or material thickness. By quenching this heated layer in water, oil, or a polymer based quench, the surface layer is altered to form amartensitic structure which is harder than the base metal.

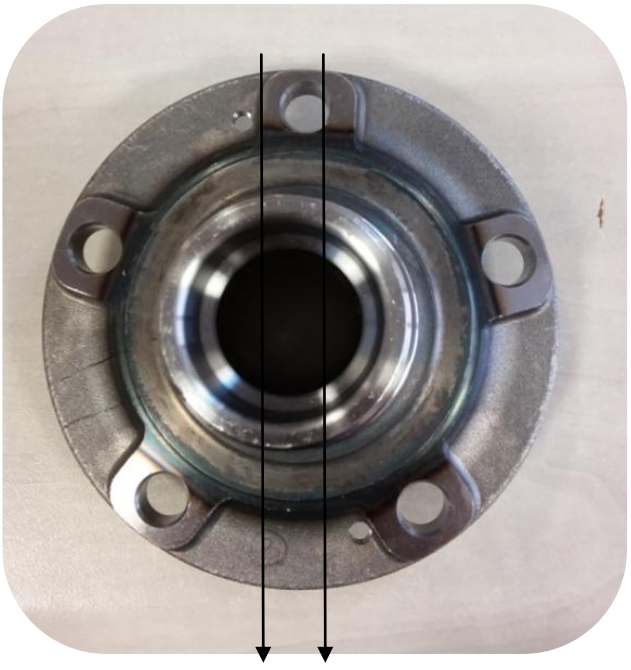




Induction Heating

Investigated samples with requested cutting lines.





SERVOCUT 401-AA-AX

Automatic Abrasive Cutting Machine Programmable with 5,7" HMI touch screen control, with Siemens PLC control unit, with automatic chop cutting and automatic table-feed cutting systems, with various cutting methods, programmable with coloured LCD display of cutting parameters, accurate and motorized positioning of the specimen in X - Y and Z axis (X-axis for plane parallel cutting is optional), integrated feed path control, power dependent adjustable feed rate, variable cutting force, pulse cutting mode, bar graph overload display, compact cutting motor, 2200 rpm cutting speed, with electronic brake system, cutting capacity upto 130/150 mm solid stock, with cut-off wheels upto ø350/400mm, twin T-slotted table(Y-direction only) made of stainless steel, bottom part as rugged alloy base casting, 100 lt recirculating cooling unit with connection hoses, ready for operation.
Without clamping devices.
Includes a standard set of cutting consumables composed of;
*An assortement of 20 cut-off wheels with 400 mm dia.
*5 lt of Metcool cooling fluid.
400 V, 3 phase, 50 Hz.

	Order Code	Description
Equipment Used :	14 67	Servocut 401 - AA
Clamping Device :	15 02 x 2	MBU 1031 Vertical clamping Device with clamping shoe
	GR 0030	Quick Acting Clamping Vise Assembly, Left
Cutting Fluid :	19-902	Metcool,Nature Friendly Soluble Oil,5lt.
Cutting Disc :	19-073	Treno-S, Ø400, for Hard Steels 50-60 HRC

ECOPRESS 100

Programmable Automatic Mounting Press with one cylinder, 5,7" HMI touch screen control, with Siemens PLC control unit, programmable with coloured LCD display, program based mounting sequences, electro hydraulic pressure (requires no air), pressure upto 300 bar, temperature upto 200 ^{0}C, operation time upto 59:99 minutes, short cycle time, thermostatically controlled heating power of 1250W, automatic cooling cycle with two three modes of cooling rates(fast standard cooling,slow cooling and based on time), programmable preheating and preloading, selectable mould sizes from 25 mm to 50 mm, audible warning signal, ready for operation.
230 V, 1-phase, 50 Hz.
Mould assemblies are ordered seperately.
Includes a standard set of mounting consumables composed of 3 different hot mounting compounds; 1 kg of each and a total of 3 kg.

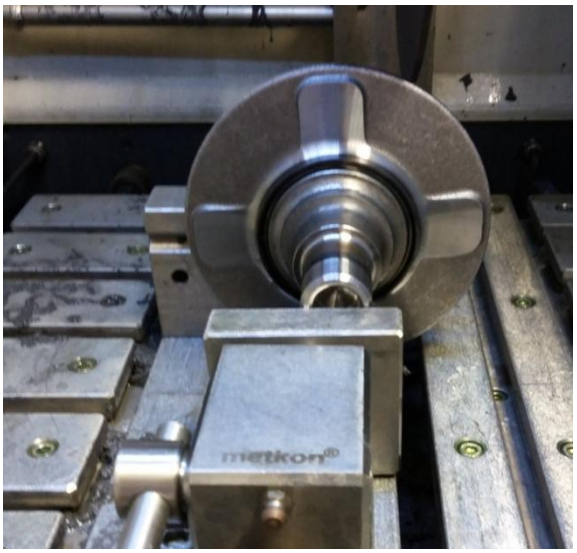
	Order Code	Description
Equipment Used	25 07	ECOPRESS 100 Automatic Mounting Press
	26 06-02	Mould Assembly, 40mm with intermediate ram
Mounting Powder	29 012	DAP 1kg.

DIGIPREP 301
Programmable with coloured 5,7" HMI touch screen control, with Siemens PLC control unit. Base Unit with large 0,75HP Motor, Variable wheel speed 50-600 rpm, Quite belt drive, Complementary or Contra rotational direction, Soft Start and Stop function,
Retractable water hose, with water supply and drain tubes.
sample preparation parameters, central and/or individual
force application, steel mounting column, with variable
specimen holder speed 50-150 rpm, 100 Watt DC motor,
LED lighting, quick-locking swing mounted design,
audible warning signal, with holding chuck. Air supply tubes,
Complete and ready for operation. Without Specimen Holders.
230 V, 1-phase, 50 Hz.
Includes working kit "300 mm Aluminium wheel and splash guard",
Includes the following standard set of consumables;
*Special Magnetic Foil, Ø 300 mm.
*Thin Metal Plate(1 pcs), Ø 300 mm
*Magneto grinding disc 18 mic., 300 mm dia.
*An assortement of 5 polishing cloths 300 mm dia.
*Diamond suspensions one of each of 6 mic. and 1 mic., plus lubricant

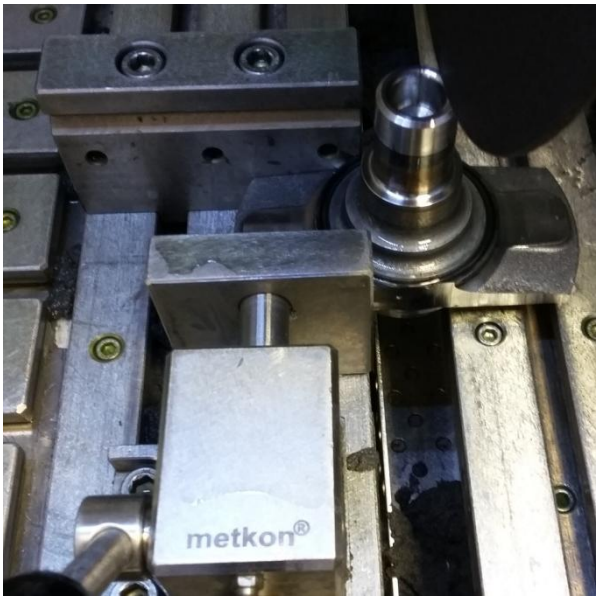
	Order Code	Description
Equipment Used	45 03	DIGIPREP 301 Grinding & Polishing System
Equipment Accessories	31 22	Aluminum wheel, 250 mm
	31 63	Splash Guard, 250 mm
	39-003-300	Ø 300 mm, Special Magnetic Foil
	39-093-300	Ø 300 mm, Thin Metal Plate(5 pcs.)

SAMPLE PREPARATION PROCESSES

As samples in different size, we have used 2 different clamping way and both of them was success. In the first clamping, we have only used GR 0030 quick acting clamping vise assembly. You can see detailed explanations below.



In these cutting operations, we have cut 2 side of sample in order to acquire parallel surfaces to take very parallel slice from sample. After that, we took the slice middle of the sample.



As can be seen, clamped sample cut with very good parallelism with X-axis. We hadn't needed to re-clamp the sample(it can cause to lose parallelism). Operation completed with only automatic X-axis movement.

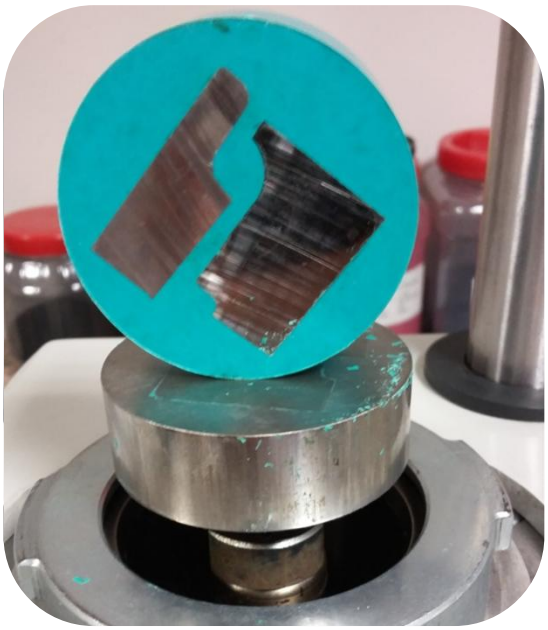
In the second clamping way, we have used 2 x 15 02 vertical clamping device with clamping shoe. You can see detailed explanations below.

Also with the help of laser unit we can see the exact cutting point on our sample as in above photos.

We clamped 2 side of sample(front and back side) and made the first cut. After that, again without any movement, we just re-located the sample with automatic X-axis. In that way sample did not moved at all.

The cutting parameters are below;

The Table feedrate is adjusted to; **100-300 µ / sec**
The Rpm is adjusted to; **2200**
The Force is adjusted to; **8A**



Mounting parameters are following;

Heating Temperature : 180°C
Pressure : 240 bar
Heating Time : 3 min
Cooling Type : Standart Cooling
Cooling Temperature : 35°C

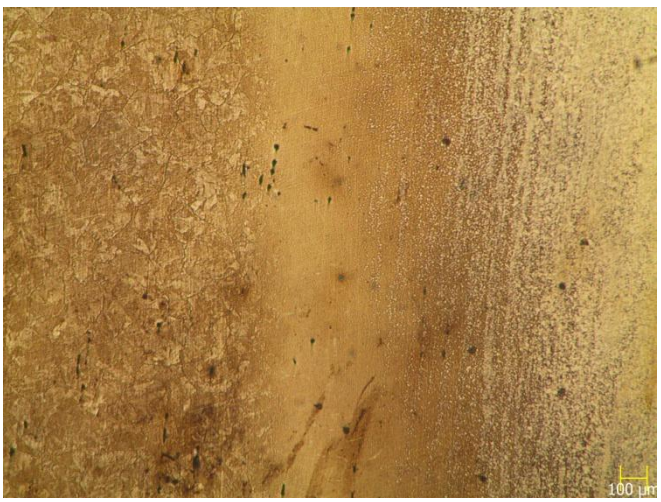
The polishing operation have been made with DIGIPREP 251 machine by using following parameters;

	Surface	***Abrasive***	***Lubricant***	***Force per Sample, (N)***	***Time (min.)***	***Disc speed (rpm) Rotation***	***Head Speed (rpm) Rotation***
Grinding Step 1	*MAGNETO I* [38-040-54]	54µ Diamond	Water	20 N	1 min.	250 *CW*	*100 CW*
Grinding Step 2	*MAGNETO II* [38-040-018]	18µ Diamond	Water	25 N	2 min.	250 *CW*	*100 CW*
Grinding Step 3	*MAGNETO III* [39-040-006]	*6µ* Diamond	*Water*	25 N	2 min.	250 *CW*	*100 CW*
Polishing Step 2	*FEDO-3* [39-025-250]	*DIAPAT-M 3µ* [39-420-M]	*DIAPAT* [39-502]	25 N	3 min.	150 *CW*	*75 CCW*
Final Polishing	*FEDO-1* [39-065-250]	*DIAPAT-M 1µ* [39-410-M]	*DIAPAT* [39-502]	20 N	2 min.	150 *CW*	*50 CCW*
Etching: Nital %3							

You can see the both slices which have been cut with 2 different way.

After the preparation; sample observed in the metallographic microscope. Microstructure of sample can be seen below.

For little piece on bakalite:



50x

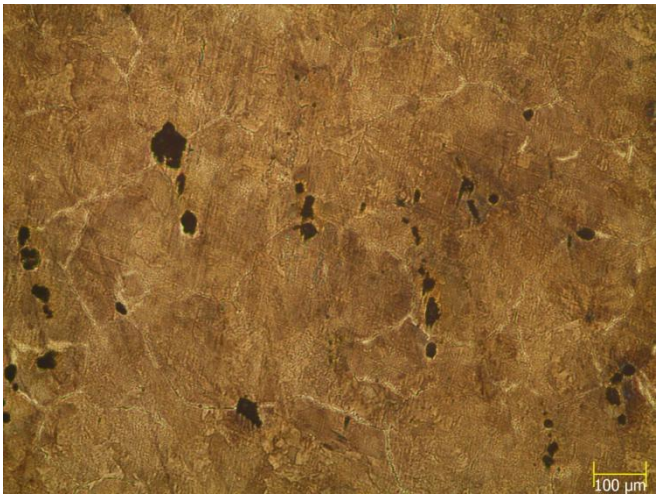
100x

100x

100x

Panoramic:

For big piece on bakalite (100x):



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