



PULSE LASER WELDING

Molds & Dies | Power Generation | Petrochemical & Heavy Industries | Aviation & Aerospace



Welding service

Wires

Machines

Training & Certification



DIN EN ISO 3834-2:2005 Certified



WWW.DSILASER.COM



CERTIFICATE

D-ZE-16083-01-00-ISO3834-2015.0053.006

DVS ZERT hereby certifies that the company

DSI Laser Service Thailand Co. Ltd.
33/1 Moo 5 Tambol Nongmaidang
20000 Chonburi
Thailand

has furnished proof to fulfil
the quality requirements for welding according to

ISO 3834-2:2021

in the extent mentioned on the reverse side.

validity: 25.11.2022 until 16.02.2026

Düsseldorf, 25.11.2022
Place and date of issue
Prof. Dr.-Ing. Kuschner
Lead Assessor


Dipl.-Ing. Gurschke
Head of certification body



DVS ZERT GmbH, Aachener Straße 172, 40223 Düsseldorf, GERMANY



Mission statement

“To reduce barriers and accelerate world’s transition to innovative welding technology for sustainable development.”

Vision statement

“To provide no.1 professionally practical pulse laser welding ecosystem.”

Core values

Diffusion: Extensively adaptation and development to support industry needs.

Service mindsets: Customer-centric strategy.

Innovation: Continuous development in pulse laser innovation for value creation.



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Milestones

Year 2000, DSI Laser Service(Thailand) Co.,Ltd., established 1st professional pulse laser welding service in Thailand, supporting automotive molds & dies.

Year 2009, Direct transferring know-how from Germany, DSI Thailand plays significant role to support major automotive manufacturers which made Thailand among top 10 of world rank in automotive production, we focussing on being solid partner in tooling maintenance operation and production car body repair.



Year 2012, DSI certified 2 significant ISO standards for pulse laser welding.

1. DIN EN ISO 3834-2:2009 Quality requirements for fusion welding of metallic materials Part 2: Comprehensive quality

2. EN ISO 14732 : 2013 Welding personnel-Qualification testing of welding operators and weld setters for mechanized and automatic welding of metallic materials



By the result of that, we start supporting power generation industry and petrochemical industry. Becoming the 1st time in Thailand that pulse laser welding technology could secure process stability and reliability in critical components repair & maintenance.



Year 2019



Year 2012

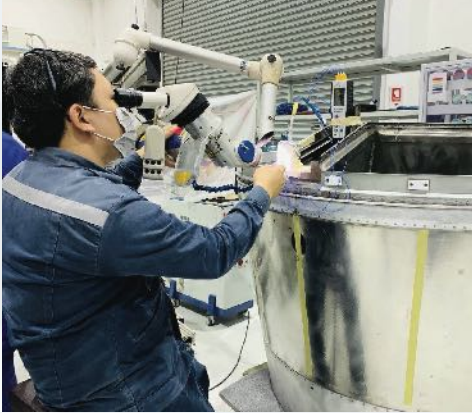


Year 2009



Year 2000





Year 2019, DSI Thailand support aviation and aerospace industry repair and maintenance (MRO) by certified 2 critical AWS welding standards for aviation components repair welding,

AWS C7.4 Process Specification And Operator Qualification for Laser Beam Welding

AWS D17.1 Specification For Fusion Welding For Aerospace Applications



Quick facts

16

CERTIFIED WELDERS

25

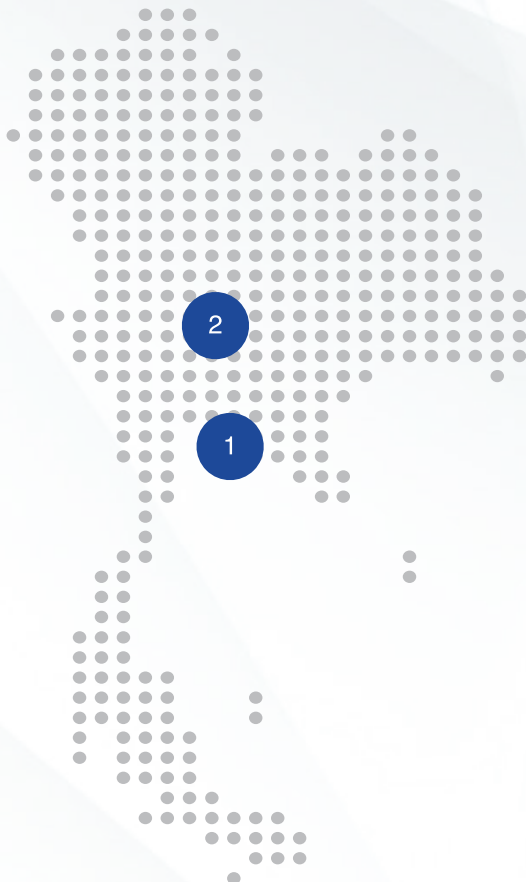
MACHINES

20

TONS CRANE

2,000

M² WORKING AREA



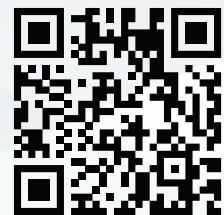
1. Chonburi Branch (Head office)

33/1 Moo 5, T.Nongmaidaeng,

A. Muang, Chonburi 20000

T: +66(0) 3821-5272

E: sales@dsilaser.com



Google map GPS

2. Phatuntani Branch (Quick service center)

Rangsit Prosper Estate 9/50,

Moo 5, T. Klungnung,

A. Klongluang, Pathumthani 12120

Tel: +66(0) 2516-5019

E: sales@dsilaser.com

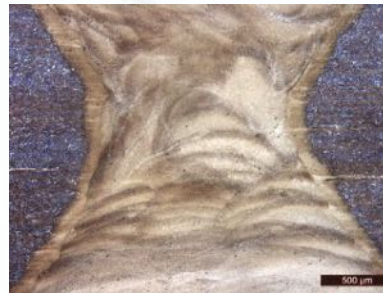


Google map GPS

From 1960 of the first invention of LASER (Light Amplification by Stimulated Emission of Radiation), we applied the uses of those light speed photon entity to many industries due to its precise characteristic of thermal transferring in every pulse radiation, from TV remote controller to surgical operation or satellite communication.

Today, pulse laser welding, we bring LASER light as pulse laser to precisely melt and connect metallic materials together, called pulse laser welding. At very small input energy (10 joules/pulse) and speed of light, we found so many useful results which are totally different from conventional welding methods.

Through years of studying and researching, we found many significant keys which could improve welding quality such as low heat effect and no distortion and so on. Let's check what pulse laser welding is and its capabilities.



Macro test-Material Duplex



Heat-affected-zone (HAZ)-Material Duplex

What make pulse laser welding unique?

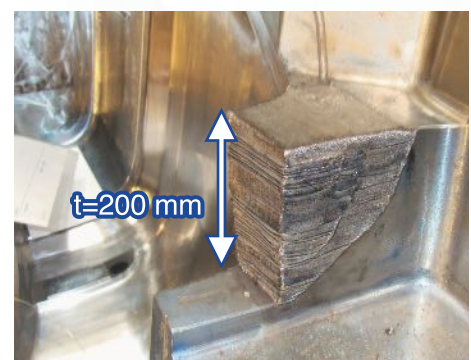
High	No	No	No
BONDING STRENGTH	PRE/POST HEATING	DISTORTION	STRUCTURE CHANGE

Comparison between conventional welding and pulse laser welding

Welding process	Input energy	Pulse speed
TIG (Argon) welding	24,000 J.	10 seconds
Pulse laser welding	10 J.	0.0005 seconds (0.5 ms)

How many layer thickness can we deposit?

Pulse laser welding perform wide range of capability to deposit on metal from base thickness 0.075 mm to unlimited. DSI recorded our maximum deposit thickness up to 200 mm.

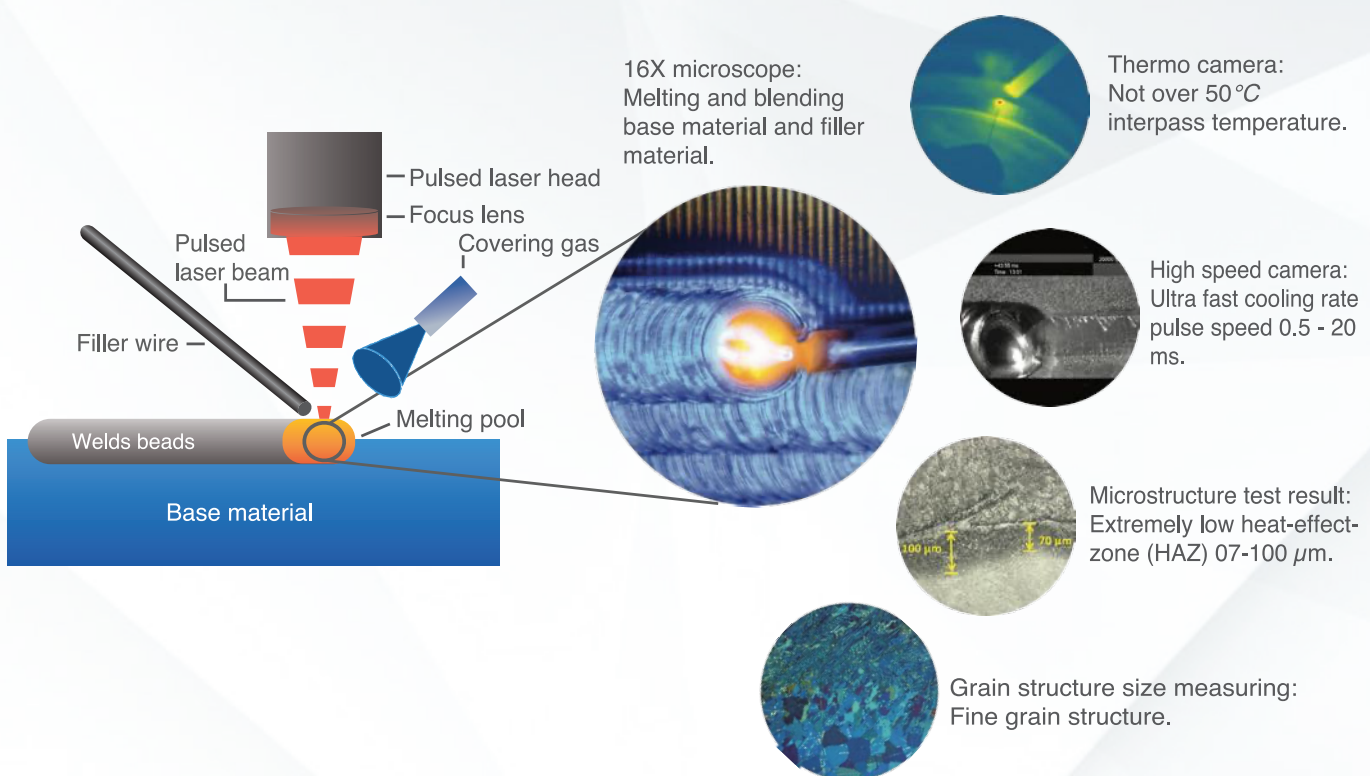


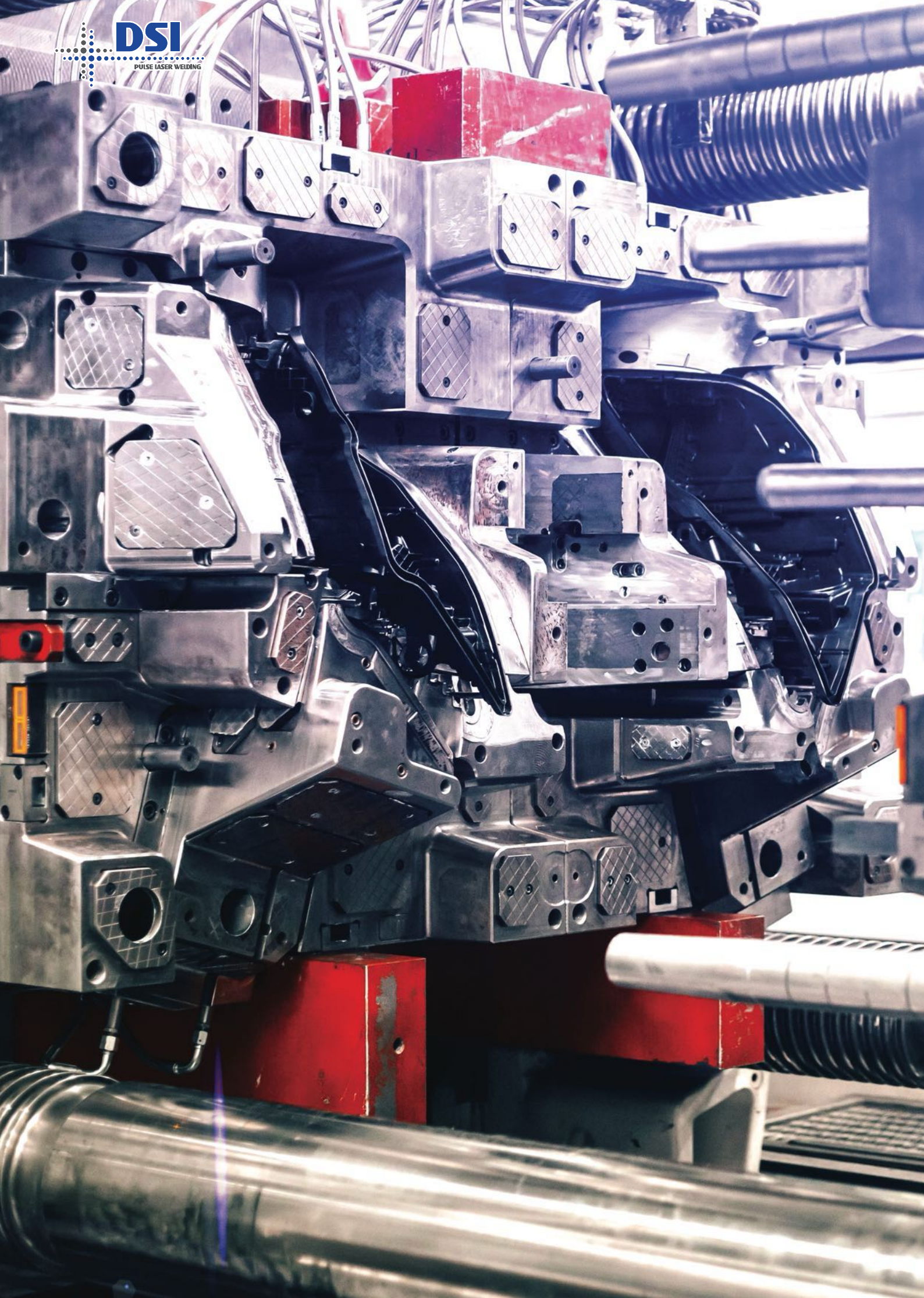
Plastic injection mold (material NAK55/10MnMo4-5)

Thermal metal depositing methods comparison

	HOVF	PTA	Laser cladding	SMAW	Pulse laser welding
Energy input source	Gas flame	Plasma/ Electric arc	CW Laser beam	Electric arc	Pulse laser beam
Heat input	Low	High	Low - Medium	High	Low
Heat-Effect- Zone * Remark material SUS431	0 mm	3.0 mm	0.1-0.2 mm	3.0-4.0 mm	0.05-0.1 mm
Bonding type	Mechanical	Metallurgical	Metallurgical	Metallurgical	Metallurgical
Bonding strength	<80 Mpa	<800 Mpa	<800 Mpa	>800 Mpa	>800 Mpa
Need preheating	No	Yes	Yes	Yes	No
Depositing thickness	0.05-0.5 mm	0.5-5 mm	0.1-10 mm	unlimited*	unlimited*
Deposit rate	1-9 kg/hr	1-5 kg/hr	1-30 kg/hr	1-30kg/hr	0.1-0.3 kg/hr
Porosity	>5%	100% dense	100% dense	100% dense	100% dense

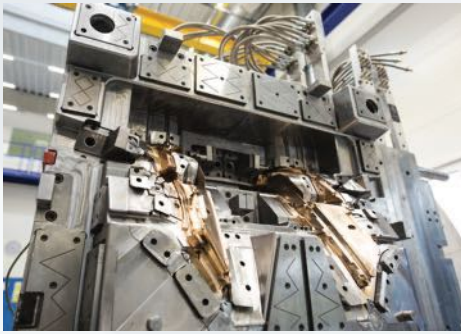
How pulse laser welding work? Let's look through various methods







PULSE LASER WELDING SERVICE



Molds & Dies

Combining to pulse laser welding technology, we design our wires for every step of Mold & dies maintenance. Not only repair but also upgrade material performance for production shots extension than ever.



Problem solution for

- Shape modification
- Flash repair at parting line
- Crack repair
- Deep areas deposit welding
- Wear and scaling areas repair
- Ejector pin holes repair
- Mirror surface finishing
- Etching surface finishing



Parting line (PL) repair for material NAK80



Diameter 7 mm, Material SKD61

Applications for

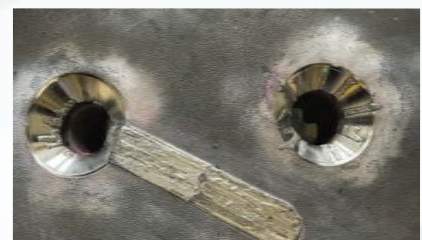


On-site
service
READY

- Plastic injection molds
- Hot forging dies
- Press dies
- Glass molds
- Aluminum die-casting molds
- Aluminum alloys
- Cast iron molds/ sand pattern
- Special mold components

Material range

- Cold work tool steels (SKD11, SKH5)
- Hot work tool steels (SKD61, MAS1, SKD4)
- Carbon steels (S45C, S55C, NAK55, NAK80)
- Stainless steels (STAVAX)
- Cast irons
- Aluminum alloys
- Nickel alloys (Niti3, Inconel 625)
- Copper alloys (BeCu, CrCu)
- Titanium alloys
- Platinum



Forge die 120 mm depth crack repair, material



10 tons plastic injection mold, material NAK55



Solutions

- Mirror surface repair
- Parting lines (PL) repair
- Deep area (Rib) repair
- Grain etching surface repair
- Ejector pin holes repair

Plastic injection moulds maintenance is where handcraft and innovation meets, we develop wire DSI M90 PK which name by “**Polish Kraft**” (polishing force) to enhance performance in high surface roughness finishing and even color matching.



Easy finishing

Thanks to lower heat input and very fine grain structure wire DSI M90 and DSI M90 PK.

Superior finishing roughness performance

Thanks to wire materials's fine grain structure and meticulously production process, DSI wires deliver you high polishing performance designed for plastic injection molds maintenance to covering wide range polishing from #200 to #30,000.

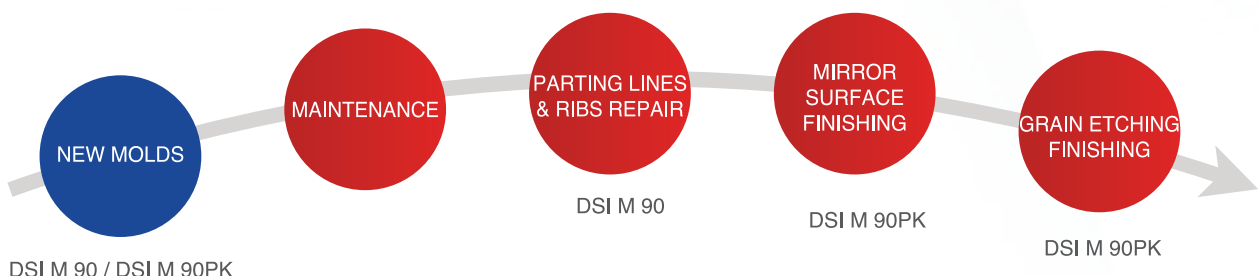
Maintenance cost reduction

From a small dot to whole parting line area, welding jobs surface finishing can go super easy by final high speed machining or hand finishing. DSI wires are designed to perform harmonious welding hardness in each beads and layers. Now you can save time, tools and tasks by skipping rough machining.

50% faster maintenance time

putting all together, maintenance should 50% faster with no need of reworks.

Overview for plastic injection molds solution



Application: Die-casting molds maintenance

Solutions

- Shape modification
- Crack repair
- Deep area deposit welding
- Wear and scaling area repair
- Ejector pin holes repair



50% faster maintenance time

When welding can do without pre/post heat treatment and hand finishing process can perform, then almost maintenance time could be reduced to 50%.

Better strength

means more production shots extended.

SKD61 1,600 Mpa

DSI M55 1,800 Mpa 12%

MAS1C 2,000 Mpa

DSI M70/12 2,400 Mpa 20%

Easy finising

Wire DSI M70/12 performs after-weld finishing process become even easier with hardness 35 HRC then changed to 53 HRC when aging by die-casting production temperature and pressure.

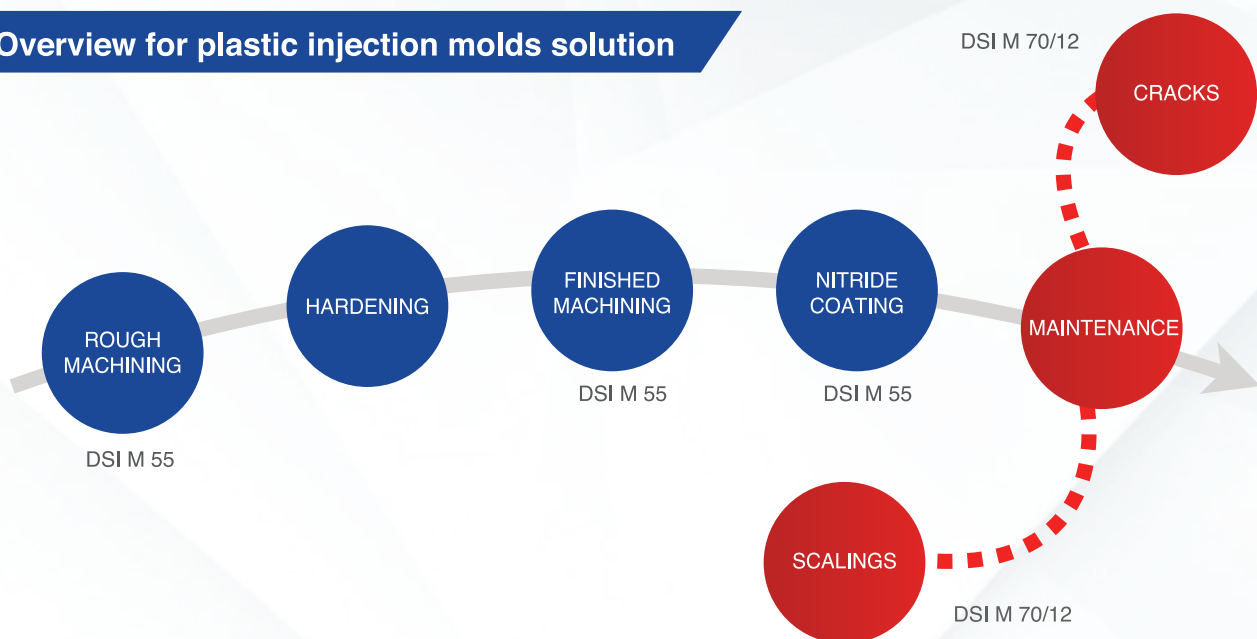
35
HRC

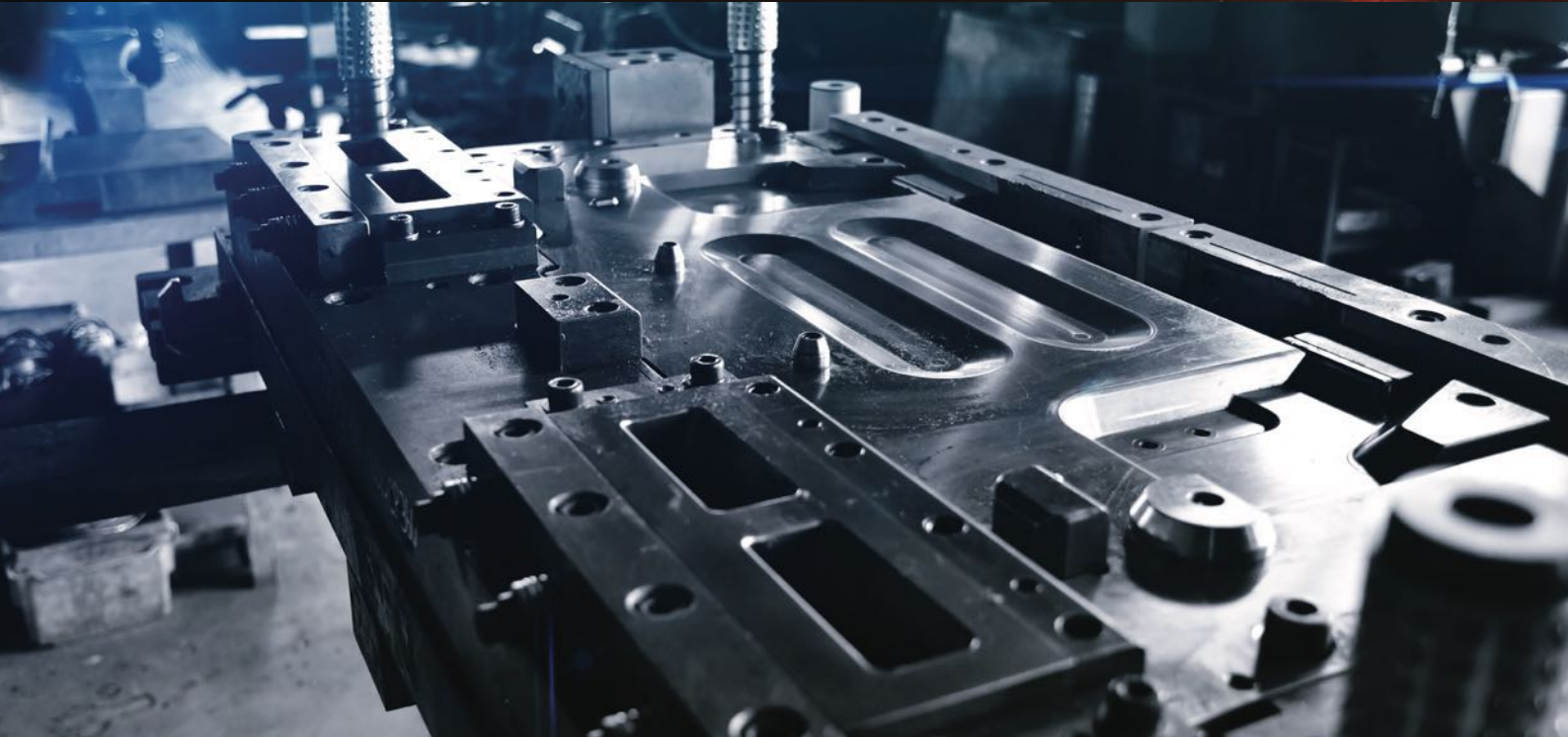
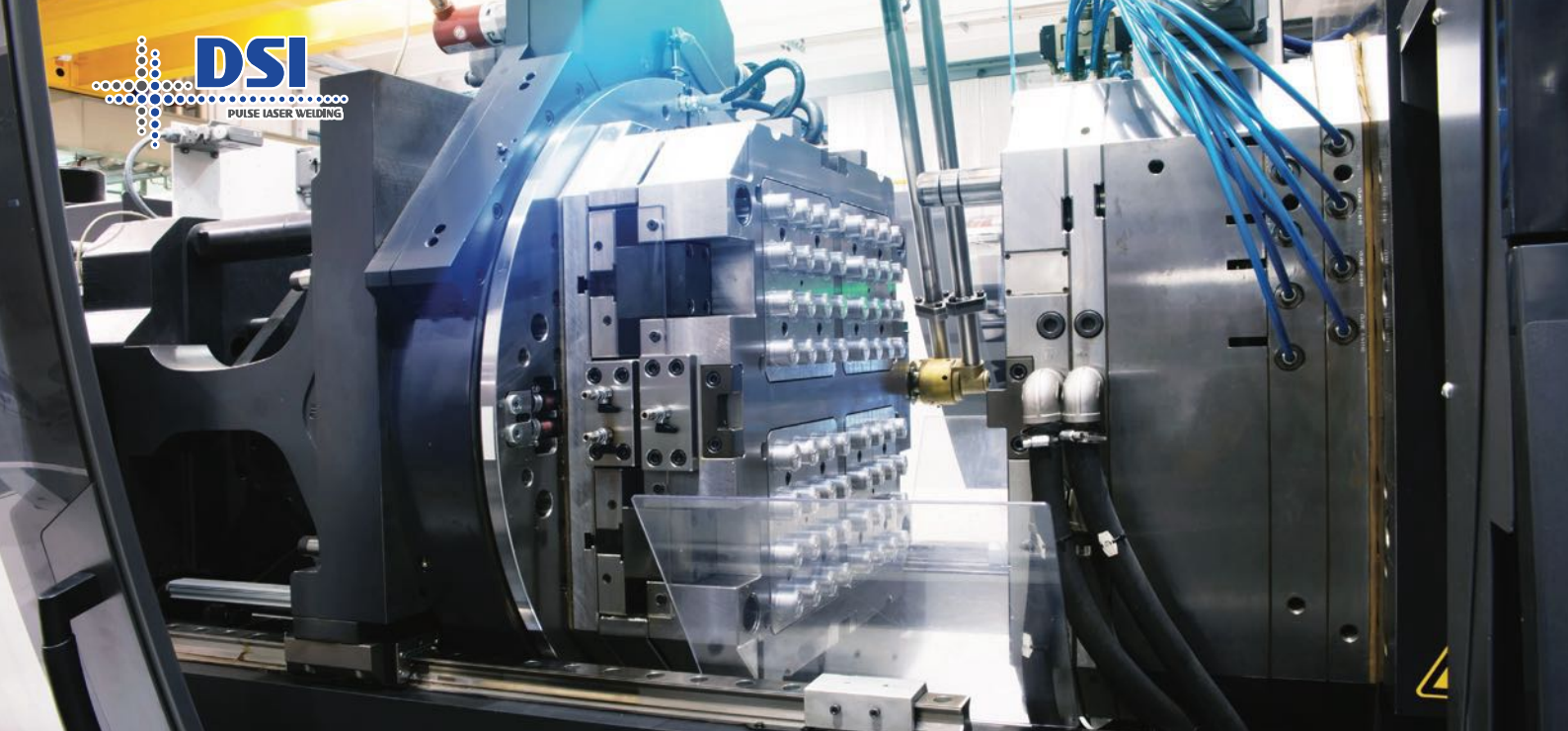
Die-casting
production

53
HRC



Overview for plastic injection molds solution





Application: Press dies maintenance



Solutions

- Shape modification
- Pin-hole (porosities) repair
- Crack repair
- Ejector pin holes repair



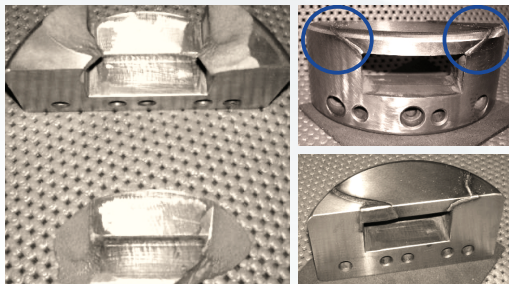
Cast Iron press die, laser welding at room temperature

Problem solution for press dies maintenance

Thanks to pulse laser welding process which transfers heat energy at very lower inter-pass temperature under 50°C, welding in room temperature, we apply to welding heat sensitive materials like cast iron and SKD11 with custom made DSI wires solution.

No concerning about hot/cold crack or dimension distortion after welded.

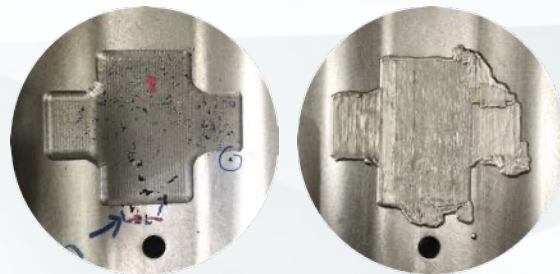
SKD11 crack/broken repair



Before

After

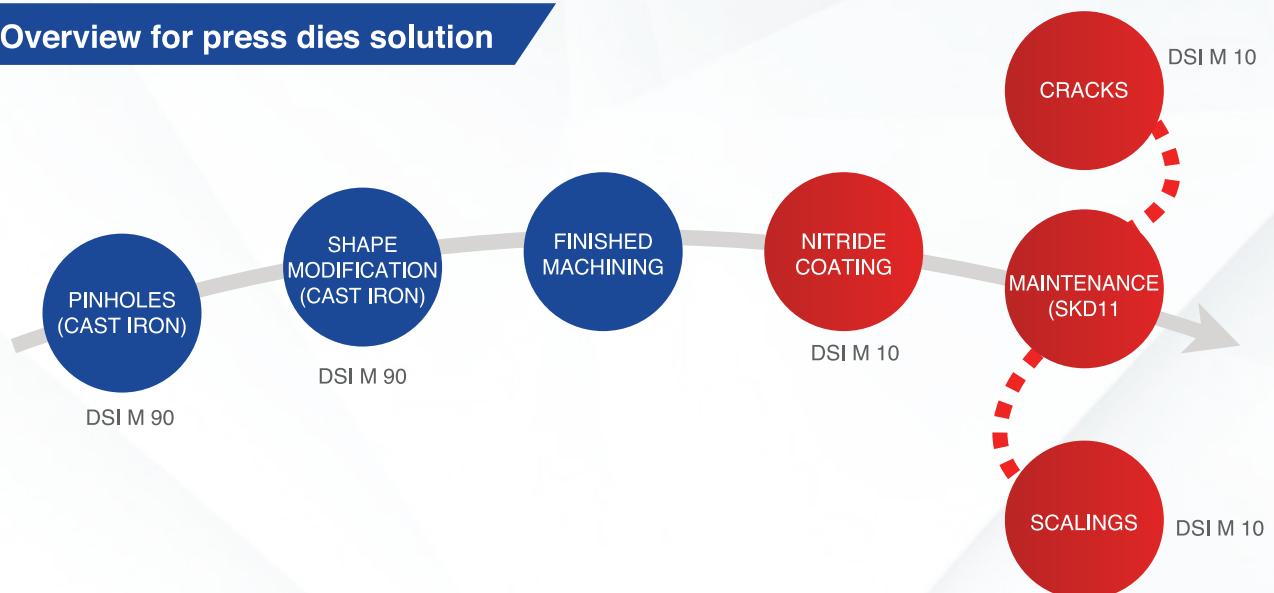
Cast iron pin holes repair



Before

After

Overview for press dies solution

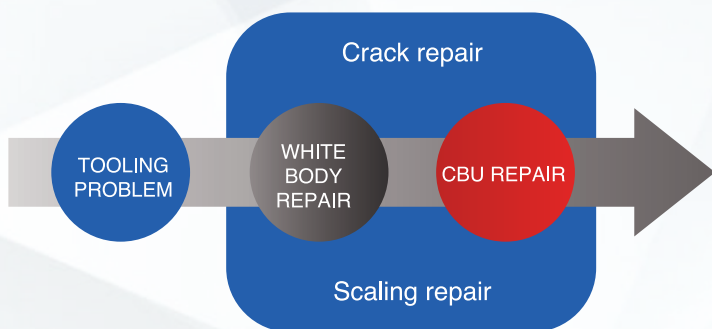






Car body repair

Pulse pulse laser welding technology secures automotive final assembly process from any defects of manufacturing process.



For increasing passenger safety, every car manufacturers are continuously developed their car body structures to use very high tensile strength steel ex. Boron steel.

Due to very high tensile steels at lower than 1 mm thickness are very difficult to stabilize forming process including conventional welding, DSI has developed our special laser welding procedure which accepted by renowned German car manufacturers for high welding strength and less side effect to car body structure.

“Car body repair (Karosseriebau)”

Through out years of service and development with many German car makers, DSI developed specific welding procedures, including filler wires, for repairing both white body and CBU (complete built unit) from cracks and scalings.



Thickness 1 mm, material Boron steel







Petrochemical industry, Marine industry and Heavy industry

By merits of pulse laser welding, DSI provide customers repair welding solution with no risk from heat-effect such as distortion, hot or cold crack after welded. In addition, development of machine to stronger power (Max.1200 Watts), unlocked the delivery time constraint of pulse laser welding.

Material range

Carbon steels: S45C, S55C, SCM440

Stainless steels: SUS304, SUS316, SUS420, Duplex, Super Duplex

Cast irons: FC250, FCD700

Aluminum alloys

Nickel alloys: Niti3, Inconel 625, Inconel 718, Hastelloy C276 and Hastelloy X

Cobalt alloys: Stellite 6, Stellite 12

Copper alloys (BeCu, CrCu)

Titanium alloys



Gear shaft dimension repair welding



Laser welding technology fulfil the needs of the industries in maintenance and repair the critical component parts. Various critical materials such as Stellite 6, AISI4140, Hastelloy, Duplex and Grey casting iron which are difficult material conditions. These materials are possibly welded with no distortion and no residual stress by pulse laser welding technology.



We operate laser welding service under Global welding standard: DIN EN ISO 3834-2: 2005 Our 2 branches, including our mobile welding service are ready to serve your needs for maintenance and repairing.

Shafts & rotors repair welding solution

Pulse laser welding, by the result of fine grain structure and low heat affected zone (HAZ), we apply this welding process to join shaft materials together (butt-joint) and keeping high strength level (in AISI4140, tensile strength over 900-1,000 Mpa).

Before

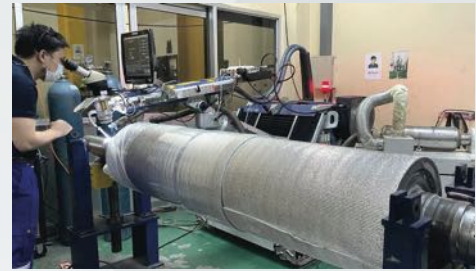


After



Pump shaft's butt-joining material AISI 4140/SCM440





Cast iron repair welding solution

Finally, pulse laser welding technology unleashed the important barrier of cast iron repair welding by applying low heat input energy and ultra-high frequency (max. 100 Hz.) which cast iron materials could not react to micro structural change especially graphitization.

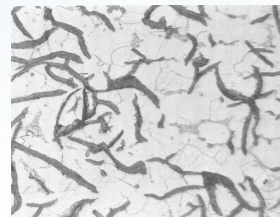
Graphitization, in cast iron, is a form of **material degradation** occurring when the microstructure of some carbon and low alloy steels breaks down after long exposure to elevated temperatures (over 420°C), causing the metal to weaken and be susceptible to cracking failures. The steel tends to break down to form iron and carbon (graphite); the latter of which will migrate to the material's grain boundaries forming graphite nodules, which are what causes the metal to become brittle, losing strength, toughness, creep resistance, and ductility.

Both grey casting (GG/FC) iron and ductile cast iron (GGG/FCD) could be welded in room temperature with no defects.

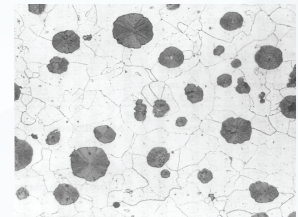
Welding in room temperature



25-years-old static casing



Microstructure of grey cast iron (GG/FC)



Microstructure of ductile cast iron (GGG/FCD)



Battleship engine crack repair.

Case study: cracks repair

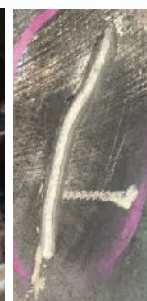
Before



After



Before



After



FC230 crack repair.





Power generation industry

When cutting edge welding technology strengthen national power security.

“From 1mm thickness steam diaphragm to 20 tons journal rotor”



No electric arc process for motor rotor

Applications for

- Steam diaphragms
- Casings
- Journal bearing rotors
- Babbitt bearings
- Generator rotors
- Motor rotors



Perfect solution for turbine rotor journal repair welding

Risk-free of electric arc

Pulse laser beam released through air to the base material without workpiece contacting or polarity connecting like in arc welding process.

This solution can solve motor rotor repairing by no need to dismantle copper wires component before welding.

Stress-free welding process.

Pulse laser welding proved not to increase stress on material after welding.

Then no need for pre/post heating.



Courtesy: Electricity Generating Authority of Thailand





Aviation industry

Supporting aviation maintenance, repair and overhaul (MRO) for critical aviation components maintenance by deliver superior welding quality even in 1 mm thickness super alloys.

Applications for

- Critical A class components ex. Ti 6242, Inconel 625 material engine components
- APU components
- Aviation components toolings ex. Aluminum alloys and Carbon steels

DSI supports aviation and aerospace industry repair and maintenance (MRO) by certified 2 critical AWS welding standards.

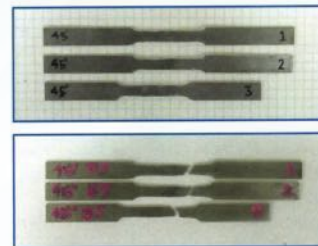
AWS C7.4 Process Specification And Operator Qualification For Laser Beam Welding
AWS D17.1 Specification For Fusion Welding For Aerospace Applications



How strong is pulse laser welding?

Mechanical test result in Ti 6-2-4-2

Without any heat treatment process, pulse laser welding perform superior welding quality by winning base material strength in tensile test.

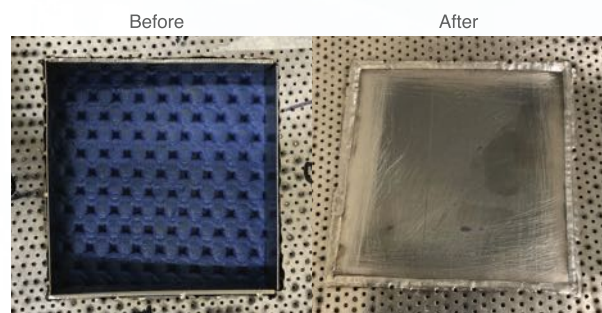
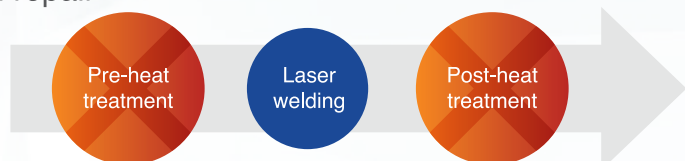


Specimen no.	Thickness (mm)	Width (mm)	Area (mm ²)	Force Max. (N)	Tensile strength (N/mm ²)	Type of failure & Location
DSI-001	0.79	6.19	4.89	5,211.279	1,065.679	Base metal
DSI-002	0.79	6.19	4.89	4,995.323	1,026.492	Base metal
DSI-003	0.79	6.19	4.89	5,241.814	1,075.398	Base metal

Case study: Aircraft engine exhaust skin repair

Base material: Inconel 625

Material thickness: 0.65 mm





LASER WELDING TRAINING

DSI Laser, provide pulse laser welding course for our internal welders and external customer with reliable training course curriculums and trainers.

In year 2020, powered by DVS SLV Hannover, we start, **“DSI Thailand Laser-Welding-Academy”**, to provide pulse laser welding training solution in Thailand for supporting our mission to reduce barriers to reach to this technology.



DSI Thailand Laser-Welding-Academy

Powered by DVS SLV HANNOVER

Introduction to pulse laser welding

DSI Laser Service (Thailand) Co.,Ltd.

Cherdchai Banpao

Thanapol Pradissun

www.dsilaser.com



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Training curriculums



Certified

Pulse Laser Welders



EN ISO 14732

Pulse Laser Welders

Aviation and aerospace



AWS D17.1 & AWS C7.4



LASER WELDING STANDARDS QUALITY ASSURANCE

Quality assurance management
EN ISO 3834-2:2005

Process specification and operator qualification for laser beam welding
AWS C7.4 / C7.4M

Laser safe regulation
BGV-B2

Filler material
EN 10204 Type 3.1

Assessment of laser
welding seams
DIN EN ISO 13919-1
(Quality class B)

Welder training
(DSI Internal welders
& external customers)

DVS 1187 & DIN ISO
24394

Laser welding machine
(Alpha Laser GmbH)
EN ISO 11553-1:2008
EN ISO 11553-2:2008
EN 60204-1:2006+A1:2009
EN ISO 13849-1:2015

Welding production
control test
DIN EN ISO 15613

Qualification testing
of operator
(DSI Internal welders
& external customers)

DIN EN ISO 14732

EN 60825-1:2015
EN60825-4:2006+A1:2008+
A2:2011
EN 207:2017

Welding procedure test
DIN EN ISO 15614-1

Filtration system
(TBH GmbH)
DIN EN ISO 14121-1

Fusion welding for aerospace
(DSI Internal welders & external customers)

AWS D17.1 /D17.1M

Quality assurance

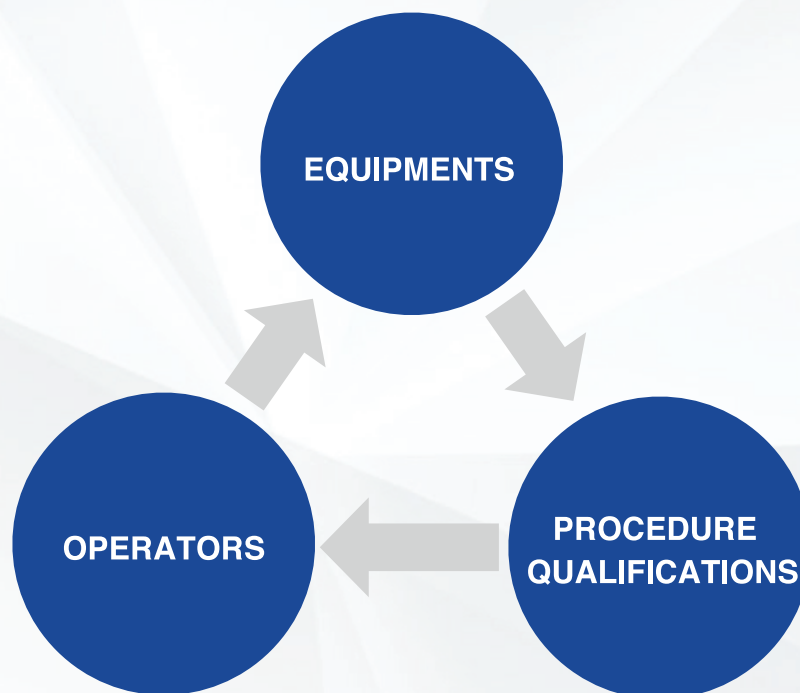
We apply international standard including AWS C7.4/ C7.4M : 2017 standard to make sure that 3 important factors are in “trusted” state.

AWS C7.4/7.4M:2017, classified 3 weld classes (A,B,C), depends on the criticality of the weld.

A class: Weld failure effect to loss of system, major components, control, contents or even endanger life

B class: Weld failure effects to system efficiency

C class: Weld failure no effects



1. Equipments qualification:

“Can our machine equipment make it?”

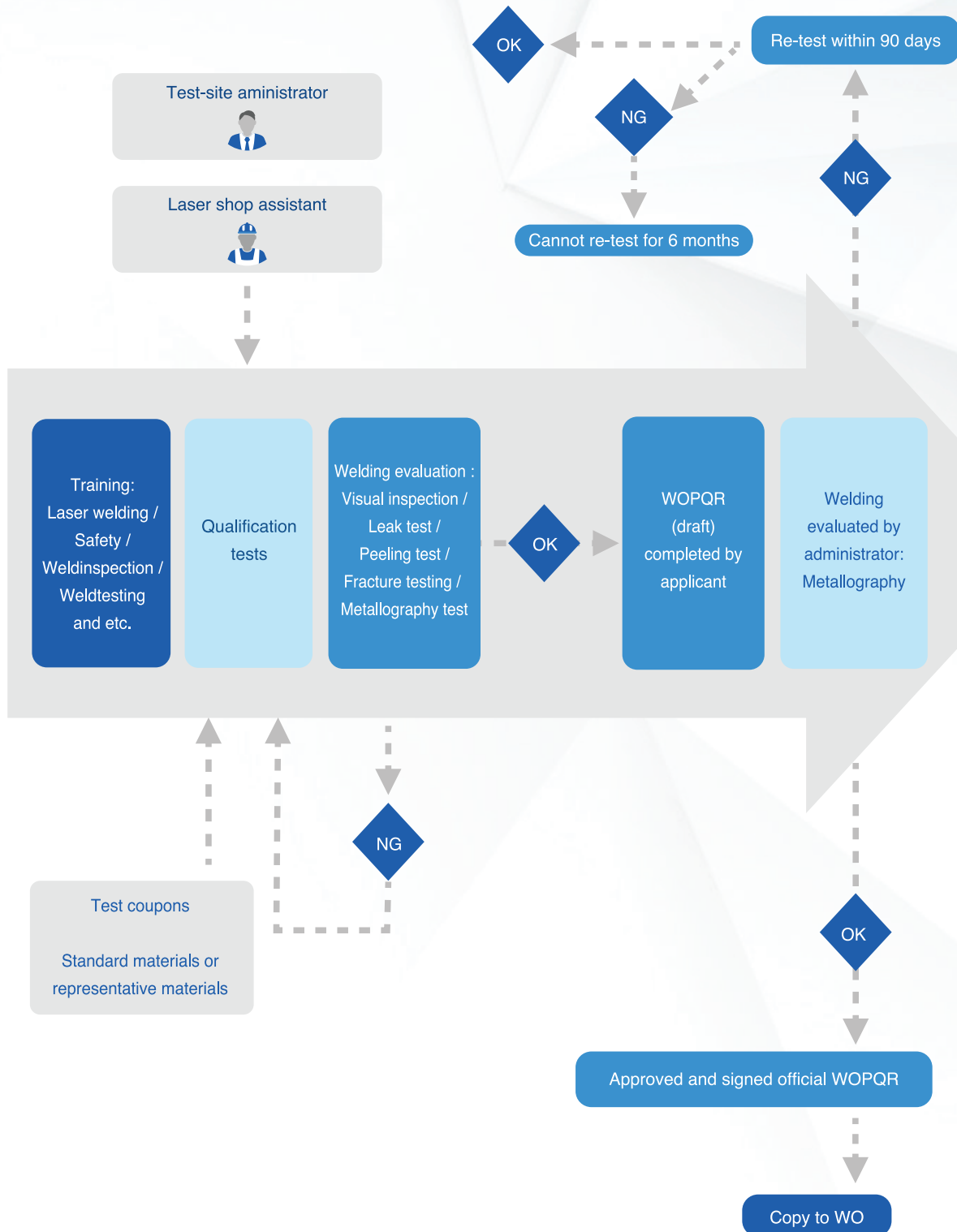
Calibration
equipment

Record result in an
EQR

Perform and record
all maintenance

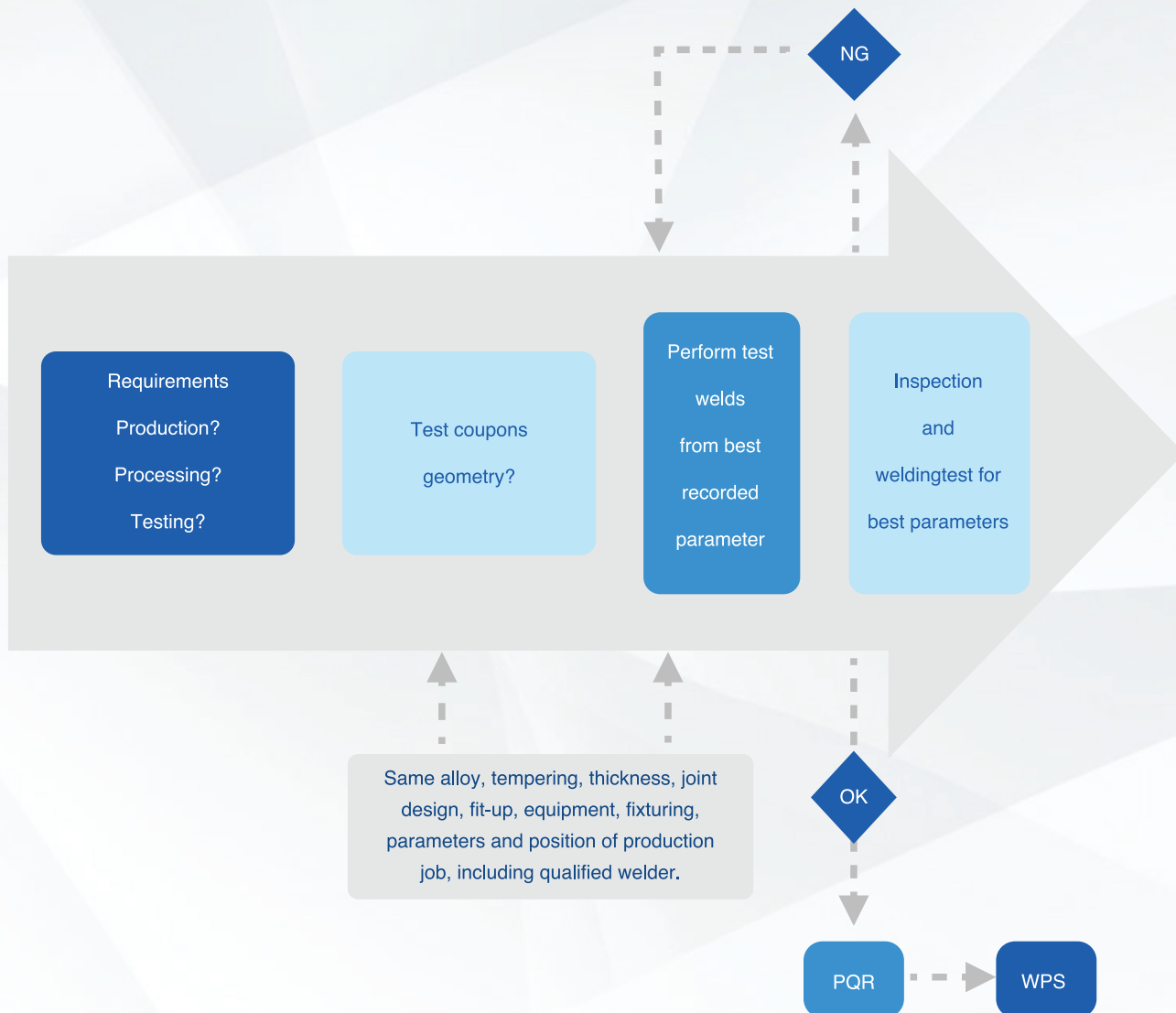
2. Laser weld operator qualification:

“Can our welder make it?”



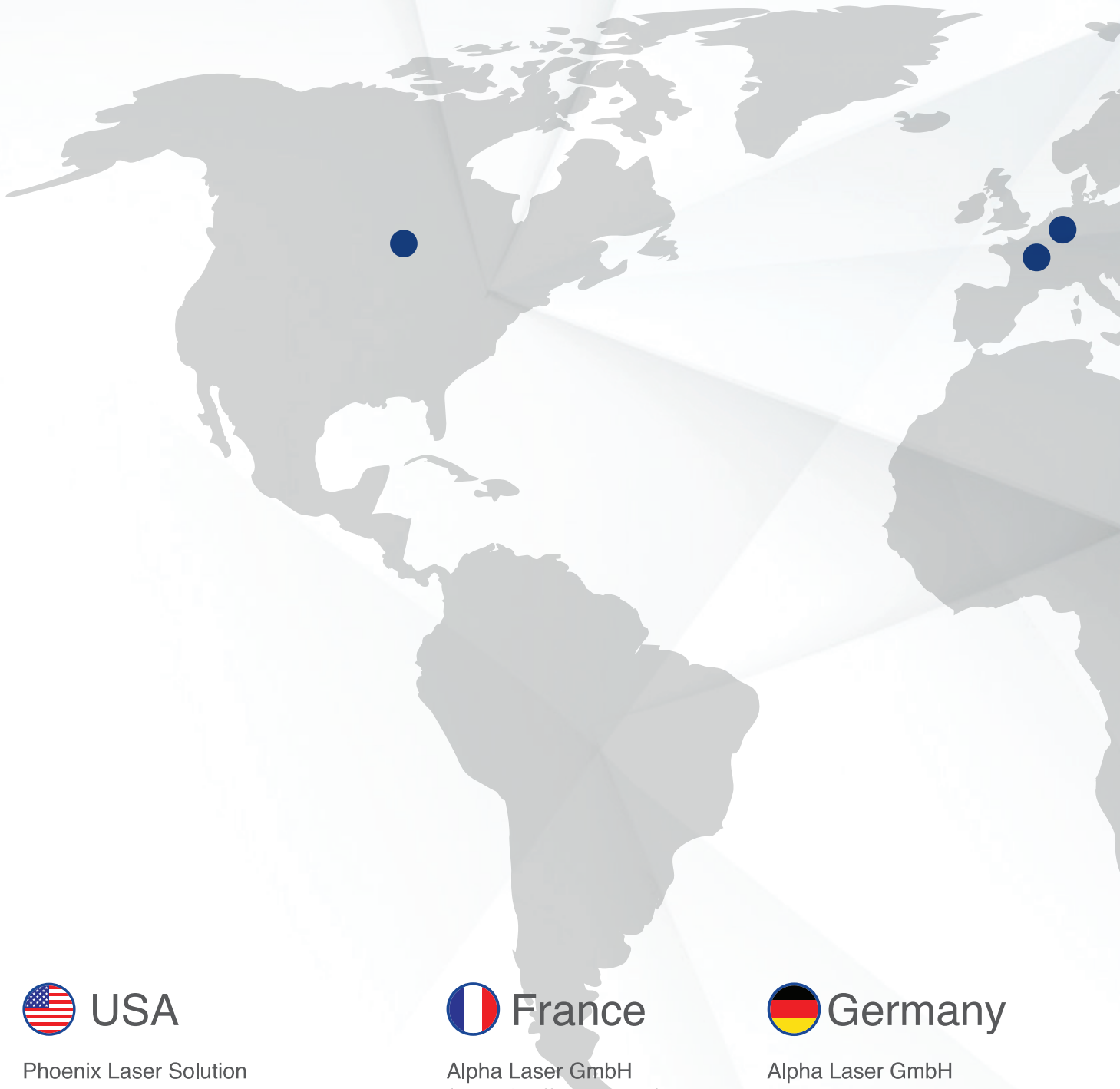
3. Laser weld Produce qualification:

“What parameter do we use to make it?”





GLOBAL TEAM



USA

Phoenix Laser Solution

www.phoenixlaser.com

PENNSYLVANIA
7799 McHenry Street
Meadville
PA 16335
Tel: 814-724-3666

OHIO
1100 Main Street Bldg #6
Cuyahoga Falls,
OH 44221
Tel: 234-334-0952

MISSOURI
3660 SW US 40
Blue Springs,
MO 64015
Tel: 816-622-8397

INDIANA
28847 Central Drive
Brookville,
IN 47012
Tel: 765-310-0700

MICHIGAN
2766 3 Mile Road
Grand Rapids,
MI 49534
Tel: 616-608-2266



France

Alpha Laser GmbH (Branch office France)

www.alphakaser.de
Mr. Franck Fleury
Email: info@alphalaser.de

13 Rue de la Mouchetière, F-45140
Saint Jean de la Ruelle, France
Tel.: +33 6 33 25 40 41



Germany

Alpha Laser GmbH

www.alphalaser.de
Mr. Oliver Lochotzki
Email: info@alphalaser.de

Junkersstraße 16
82178 Puchheim, Germany
Tel.: +49(0)89 890237-0

DVS SLV Hannover

www.slv-hannover.de

Am Lindener Hafan 1,30453
Hannover, Germany



Thailand

DSI Laser Service(Thailand) Co.,Ltd.

Chonburi Branch (Head office)

33/1 Moo 5, T.Nongmadaeng,
A. Muang, Chonburi 20000
Tel.: +66(0) 3821-5272
Email: sales@dsilaser.com

Phatumtani Branch (Quick service center)
Rangsit Prosper Estate
9/50, Moo 5, T. Klungnung,
A. Klongluang, Pathumthani
12120
Tel.: +66(0) 2516-5019
Email: sales@dsilaser.com

Japan

DKN Laser Welding Co.,Ltd.

www.dknlaser.co.jp
Mr. Toshihiko Koga
Tel.: +81(0)-70-6429-0185
Email: info@dknlaser.co.jp

1-40-8 Higashiyanae, Utsunomiya-shi,
Toshigi-ken, 3321-0925, Japan

Chunichi Craft Corp.

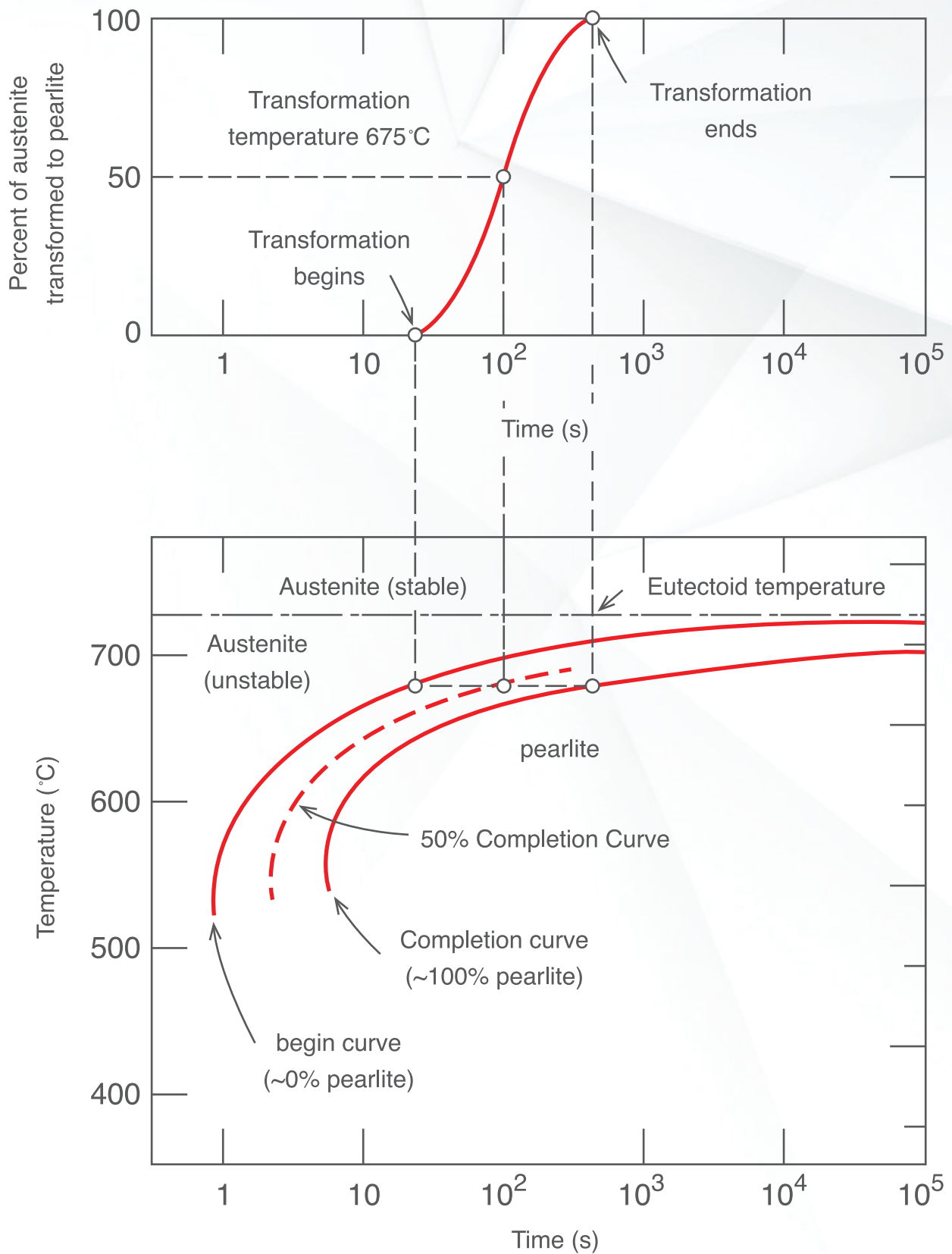
www.chu-cra.co.jp
Mr. Kenji Iwaskow
Tel.: +81(0)-56-8314-005
Email: ivashukofu@chu-cra.co.jp

1-3-21 Miyuki-cho, Kasugai-shi,
Aichi-ken, 486-0953, Japan



KNOWLEDGE & REFERENCE

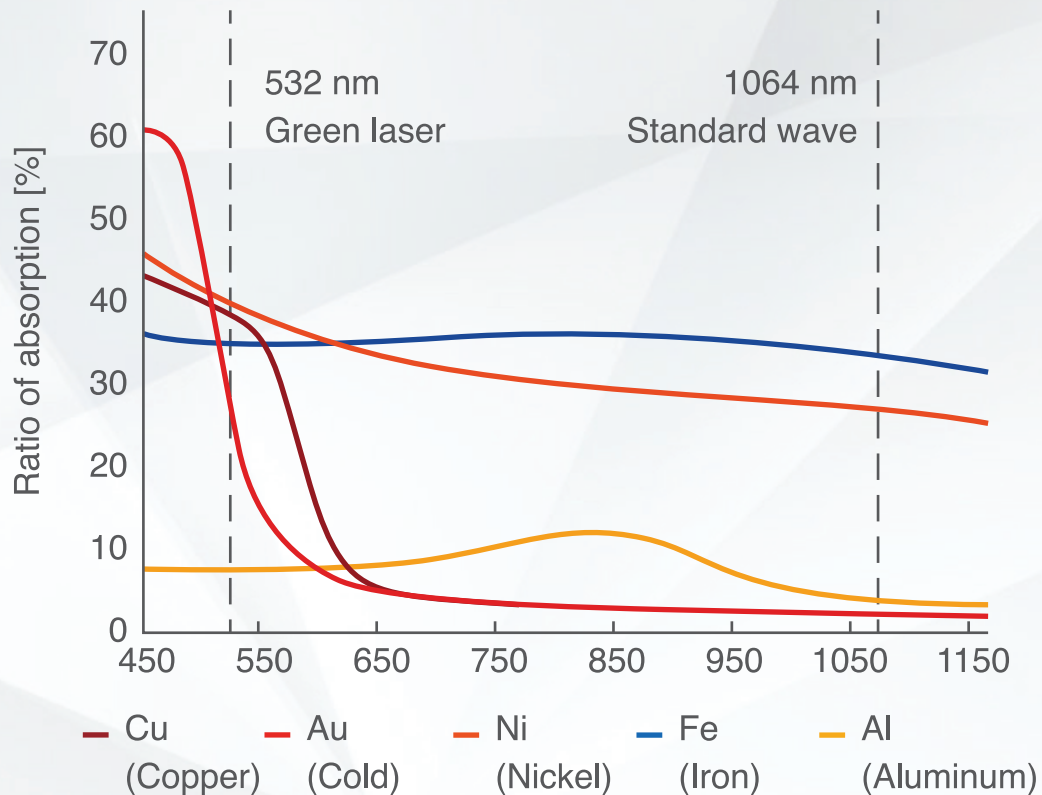
Isothermal transformation (or TTT) Diagrams (Temperature, Time, and % Transformation)





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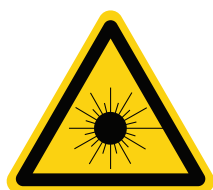
Materials' light absorption rate & light reflection rate



Maerial	Symbol	1-R	J/mm3
Aluminum	Al	0.10	26.1
Chromium	Cr	0.40	20.4
Ferrous	Fe	0.35	21.9
Gold	Au	0.02	196
Cobalt	Co	0.32	23.7
Copper	Cu	0.06	92.8
Magnesium	Mn	1	6.4
Nickel	Ni	0.28	29.8
Palladium	Pd	0.26	23.8
Platinum	Pt	0.27	27.0
Rhodium	Rh	0.17	50.6
Silver	Ag	0.03	114
Titanium	Ti	0.40	14.2

Approximate Hardness Conversion Numbers for Non-Austenitic Steels (Rockwell C Hardness Range)

Rockwell C	Vickers	Brinell Hardness Number C		Rockwell Hardness Number		Rockwell Superficial Hardness Number		
		10-mm	10-mm			15 N Scale,	30 N Scale,	45 N Scale,
Hardness	Hardness	Standard	Carbide	A Scale,	D Scale,	15 N Scale,	30 N Scale,	45 N Scale,
Number 150 kgs	Number	Ball, 3000-kgs	Ball, 3000-kgs	60-kgf (HRA)	100-kgf	15-kgf	30-kgf	45-kgf
(HRC)	(HV)	(HBS)	(HBS)	(HRA)	(HRD)	(HR 15-N)	(HR 30-N)	(HR 45-N)
68	940	...	...	85.6	76.9	93.2	84.4	75.4
67	900	...	...	85.0	76.1	92.9	83.6	74.2
66	865	...	...	84.5	75.4	92.5	82.8	73.3
65	832	...	(739)	83.9	74.5	92.2	81.9	72.0
64	800	...	(722)	83.4	73.8	91.8	81.1	71.0
63	772	...	(705)	82.8	73	91.4	80.1	69.9
62	746	...	(688)	82.3	72.2	91.1	79.3	68.8
61	720	...	(670)	81.8	71.5	90.7	78.4	67.7
60	697	...	(654)	81.2	70.5	90.2	77.5	66.6
59	674	...	634	80.7	69.9	89.8	76.6	65.5
58	653	...	615	80.1	69.2	89.3	75.7	64.3
57	633	...	595	79.6	68.5	88.9	74.8	63.2
56	613	...	577	79.0	67.7	88.3	73.9	62.0
55	595	...	560	78.5	66.9	87.9	73	60.9
54	577	...	543	78.0	66.1	87.4	72	59.8
53	560	...	525	77.4	65.4	86.9	71.2	58.6
52	544	(500)	512	76.8	64.6	86.4	70.2	57.4
51	528	(487)	496	76.3	63.8	85.9	69.4	56.1
50	513	(475)	481	75.9	63.1	85.5	68.5	55.0
49	498	(464)	469	75.2	62.1	85	67.6	53.8
48	484	451	455	74.7	61.4	84.5	66.7	52.5
47	471	442	443	74.1	60.8	83.9	65.8	51.4
46	458	432	432	73.6	60	83.5	64.8	50.3
45	446	421	421	73.1	59.2	83	64	49.0
44	434	409	409	72.5	58.5	82.5	63.1	47.8
43	423	400	400	72.0	57.7	82	62.2	46.7
42	412	390	390	71.5	56.9	81.5	61.3	45.5
41	402	381	381	70.9	56.2	80.9	60.4	44.3
40	392	371	371	70.4	55.4	80.4	59.5	43.1
39	382	362	362	69.9	54.6	79.9	58.6	41.9
38	372	353	353	69.4	53.8	79.4	57.7	40.8
37	363	344	344	68.9	53.1	78.8	56.8	39.6
36	354	336	336	68.4	52.3	78.3	55.9	38.4
35	345	327	327	67.9	51.5	77.7	55	37.2
34	336	319	319	67.4	50.8	77.2	54.2	36.1
33	327	311	311	66.8	50	76.6	53.3	34.9
32	318	301	301	66.3	49.2	76.1	52.1	33.7
31	310	294	294	65.8	48.4	75.6	51.3	32.5
30	302	286	286	65.3	47.7	75	50.4	31.3
29	294	279	279	64.8	47	74.6	49.5	30.1
28	286	271	271	64.3	46.1	73.9	48.6	28.9
27	279	264	264	63.8	45.2	73.3	47.7	27.8
26	272	258	258	63.3	44.6	72.8	46.8	26.7
25	266	253	253	62.8	43.8	72.2	45.9	25.5
24	260	247	247	62.4	43.1	71.6	45	24.3
23	254	243	243	62.0	42.1	71	44	23.1
22	248	237	237	61.5	41.6	70.5	43.2	22.0
21	243	231	231	61.0	40.9	69.9	42.3	20.7
20	238	226	226	60.5	40.1	69.4	41.5	19.6



DSI LASER SERVICE (THAILAND) CO.,LTD.

T : +66 (0) 038215272
M : +66 (0) 982754833
E : sales@dsilaser.com



WWW.DSILASER.COM