



내마모성·저변형·국부열처리

**LASER HARDENING**

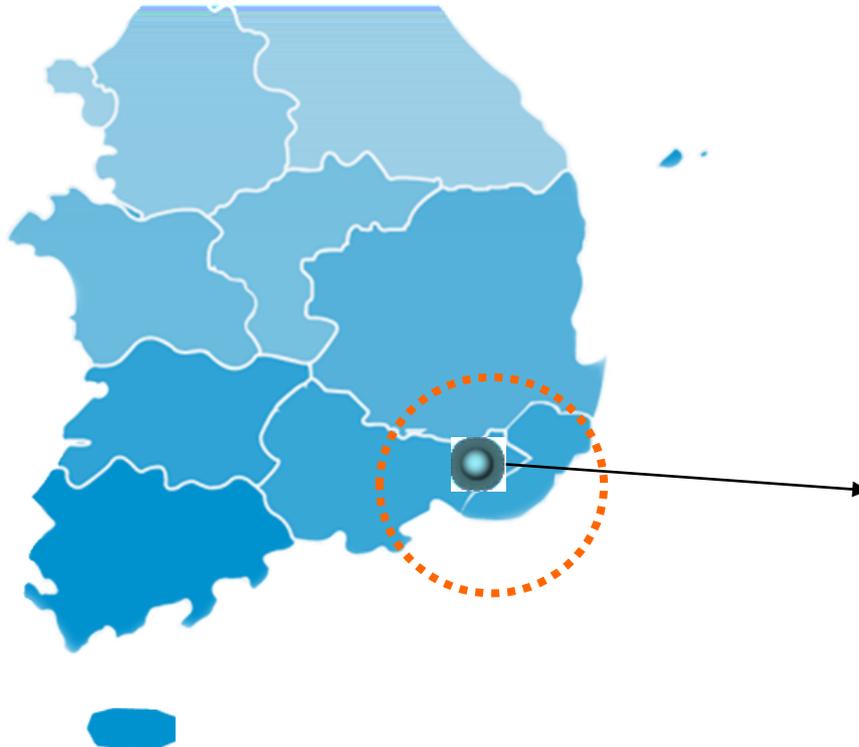
레이저 열처리

## 레이저 열처리 기술 소개와 레이저 열처리 적용 제품

2019. 10. 31.

주식회사 상도티디에스

- 1994년 설립된 열처리 전문기업
- 주생산품목 : 자동차, 중장비, 산업기계부품  
주조 단조품의 열처리
- 종업원 : 24명
- 위치 : 경남 김해시 상동면 소락로 196



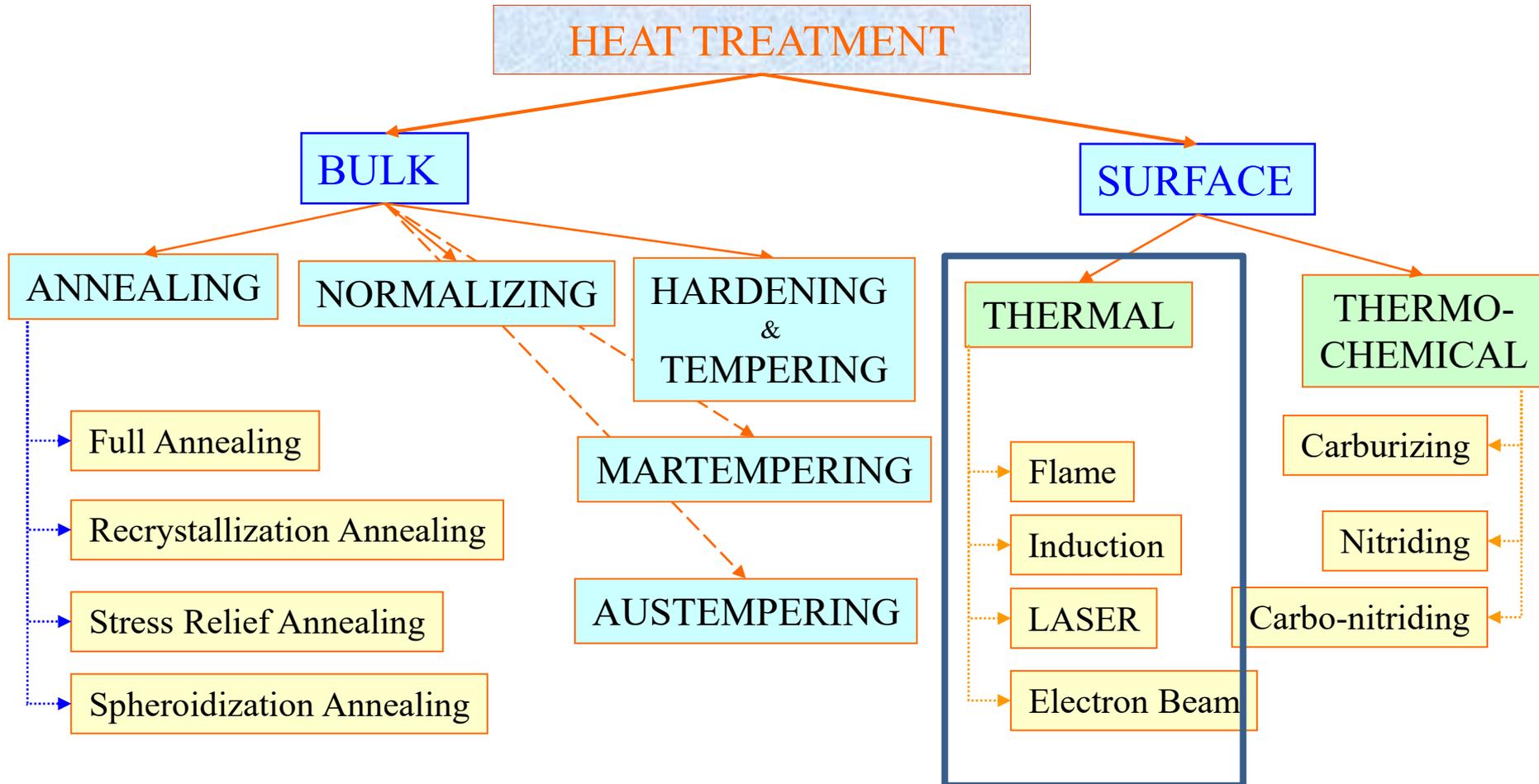
## <생산품목>



## <신규사업>



HYUNDAI Drive your way™	KIA	GM	DRB
LG전자	TOYOTA Smile for Tomorrow	BMW	Audi
현대중공업	SKF	TIMKEN	KYB
CHRYSLER	NISSAN		





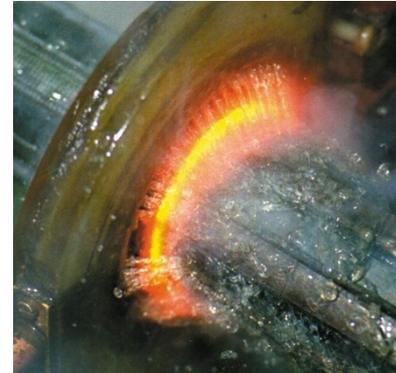
## ■ Oven

- Heating of the complete part
- Limited size of the workpiece
- High distortion, warpage



## ■ Flame

- Manual process
- No temperature control
- Poor repeatability



## ■ Induction

- Post-processes required
- Additional cooling required
- Most closely matches laser hardening



## ■ Laser

- Closed-loop temperature control
- Homogeneous and constant case depth
- Almost no further finishing process required

# Laser Hardening

내마모성

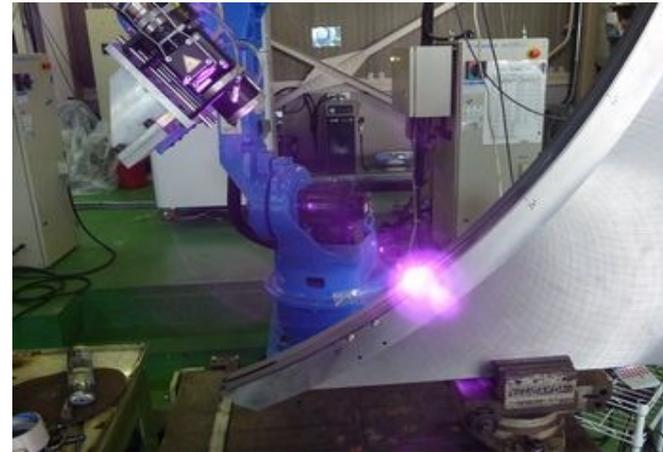
변형

국부열  
처리

공정기간

# 고민 해결

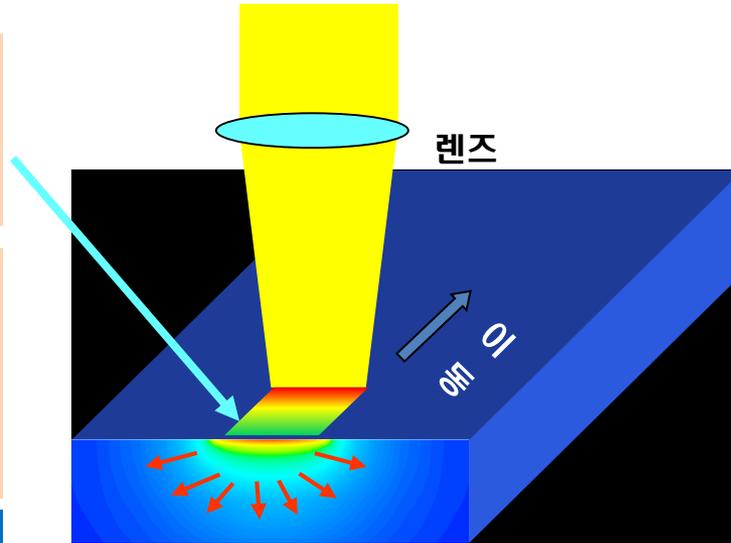
레이저 열처리는 제품에 고에너지 레이저 빔을 조사하여  
가열 → 냉각 사이클에 의해 표면만 경화시키는 표면경화기술

**기어 레이저 열처리****레일 레이저 열처리**

◆ 제품 온도  
최표면 : 용융온도 이하  
온도 분포가 발생

◆ 온도제어 방법  
레이저 파워  
빔직경  
이동속도

소입패턴에 영향



◆ 레이저 소입의 기본 현상:  
레이저에 의해 미치는 열은 제품내부로  
확산 → 급냉(1000~3000℃/s) → 소입

냉각제 불필요  
[Self cooling]

- 국부적인 열처리가 가능(부분적 경화)
- 열처리 변형 적음
- 짧은 사이클 타임
- 복잡한 형상의 경화가 가능(유연한 공정)
- 열처리 공정의 인라인화 가능
- 물에 의한 냉각이 불필요
- 부품표면의 오염이 없음



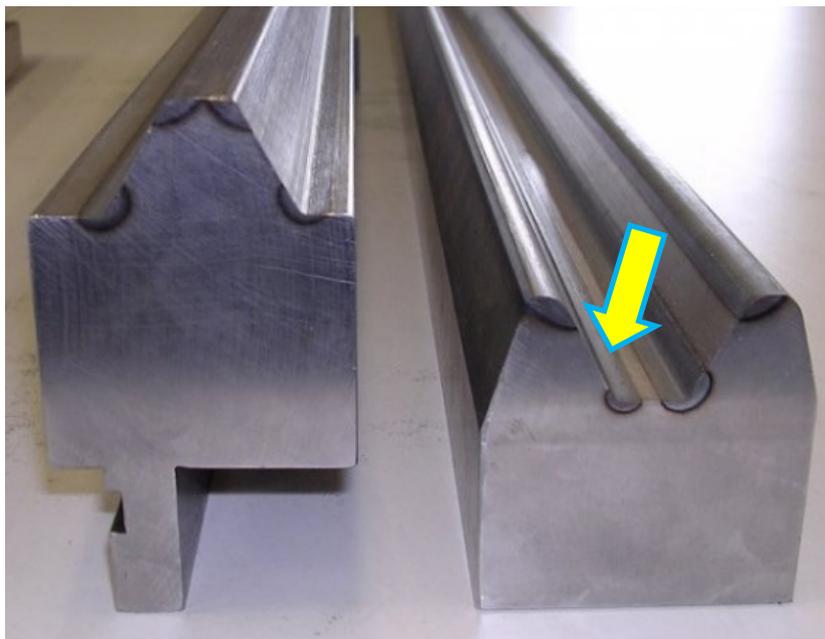
## 국부적인 열처리가 가능

경화가 필요한 부분만 가열

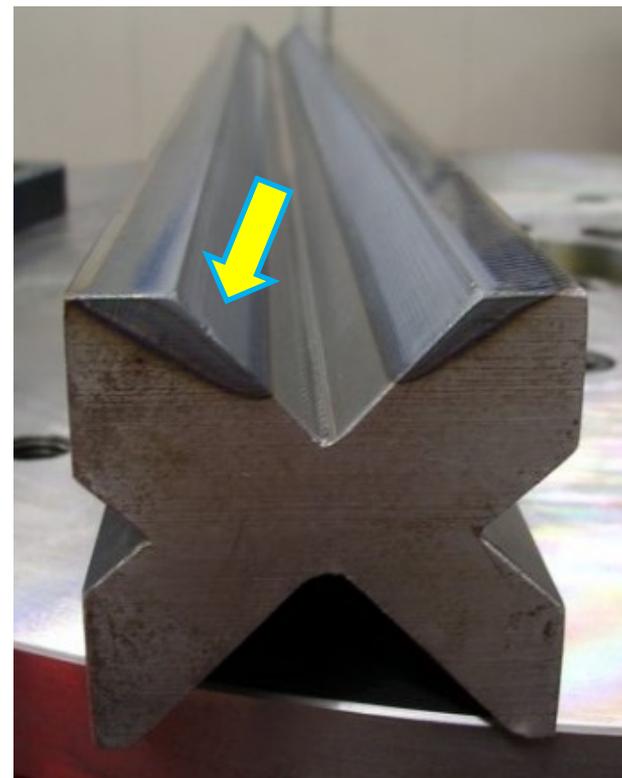


- Downholder forming tool
- 3D hardness traces :  
[8 mm wide]
- Material : X155CrVMo12-1  
[DIN No. 1.2379]
- cycle time: approx. 90 min
- laser power : Max. 1,500 W

## 필요한 부분만 국부적인 열처리가 가능

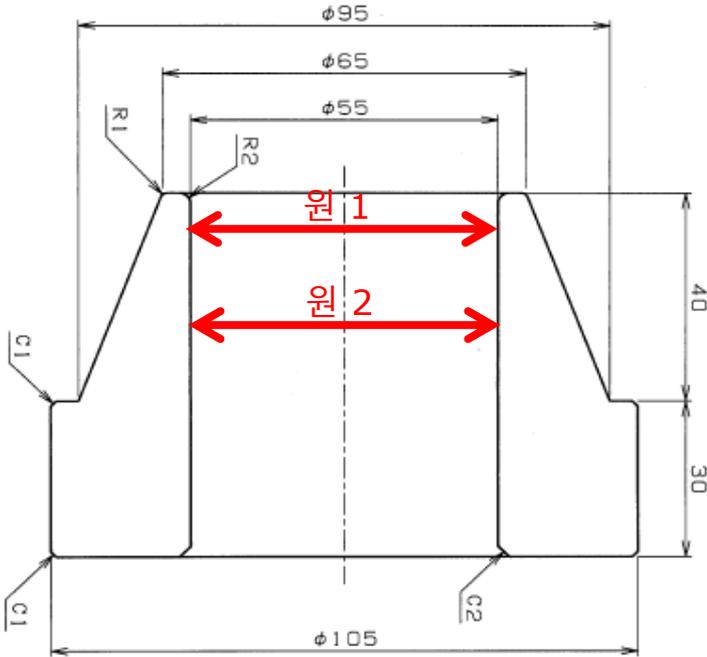


**Kant tool**  
laser hardening  
the bending edges on punch and die



**Bending tool for sheet metal :**  
bending die

열처리 변형량이 적다



재료 : S45C

고주파 소입후의 표면경도 : HRC55~58

고주파 소입시의 경화층깊이 : 1.5mm이상

레이저 소입후의 표면경도 : HRC58~60

레이저 소입후의 경화깊이 : 0.5mm~0.8mm



고주파 소입후의 치수 변화량

직경\_원 1 : +100  $\mu$ m

직경\_원 2 : +18  $\mu$ m



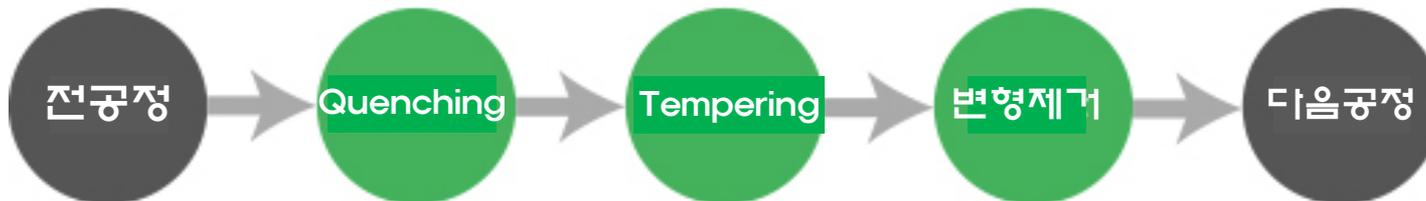
레이저 소입후의 치수량

직경\_원 1 : -5  $\mu$ m

직경\_원 2 : -3  $\mu$ m

## 공정감소

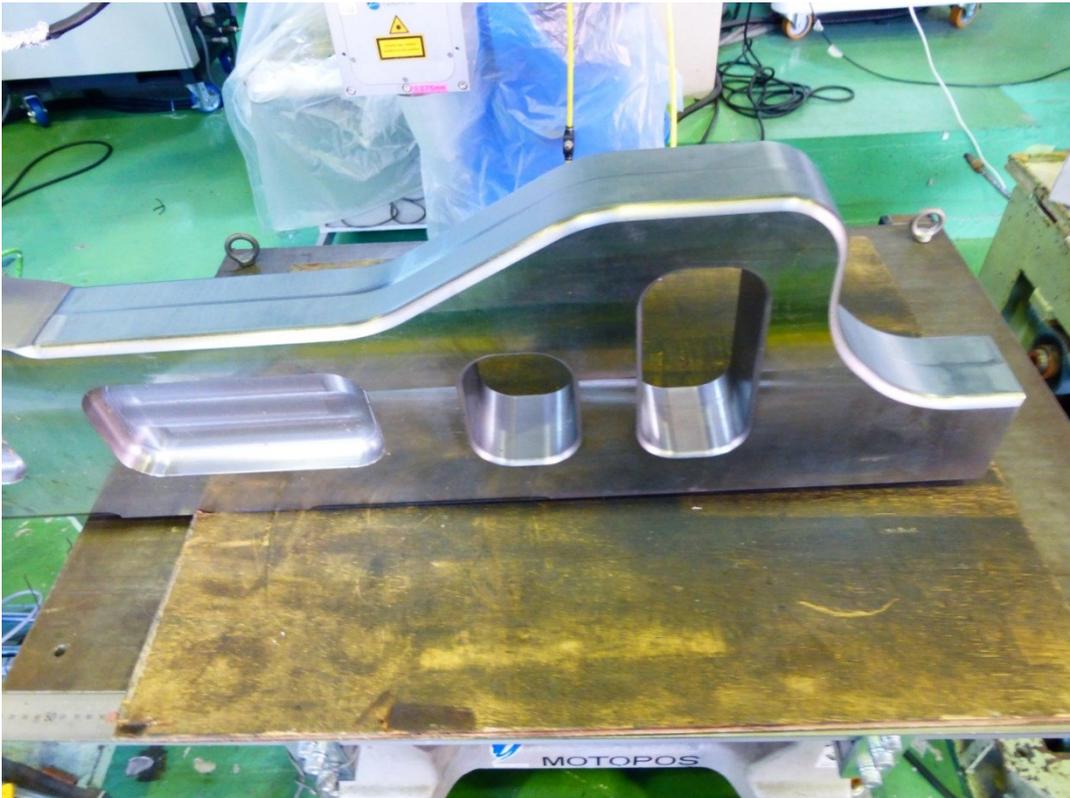
### 기존 열처리 공정



### 레이저 열처리 공정



**복잡한 형상의 소입이 가능**



**재질 : S45C**

**경도 : HRC60**

**경화깊이 : 0.5mm**

## Fundamentals - Materials

- Nearly all commonly used tool steels and cast iron grades can be treated by laser
- For hardening carbon content needs to be greater than 0.2%
- Typical applications include:
  - Transmission gears
  - Spindles
  - Shaft keyway
  - Extruder screws
  - Hemming tools
  - Dies
  - Forming tools
  - Springs
  - Pliers

Material-No.	DIN	Hardness [HRc +/- 3]
1.1730	C 45 W	57
1.2311	40 CrMnMo 7	57
1.2320	60 CrMo 10 7	60
1.2333	59 CrMo 18 5	60
1.2343	X 38 CrMoV 5 1	55
1.2363	X 100 CrMoV 5 1	62
1.2738	40 CrMnNiMo 8 6	57
1.2767	X 45 NiCrMo 4	57
1.4923	X 22 CrMoV 5 1	50
1.7225	42 CrMo 4	57
1.8159	50 CrV 4	57
0.6025	GG 25 CrMo	59
0.7070	GGG 70 L	61

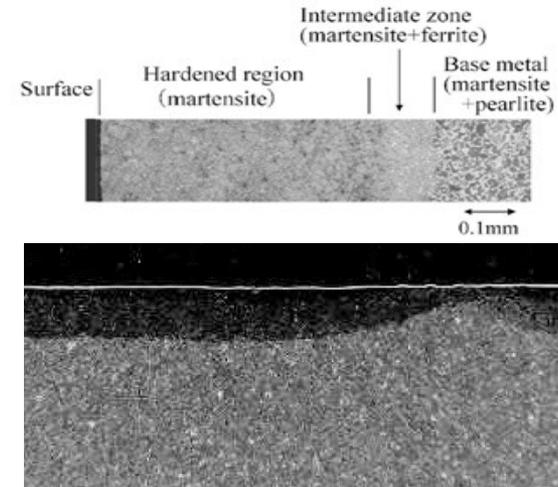
Ferrite ( $T=20^{\circ}\text{C}$ )



Austenite ( $T < T_{\text{melt}}$ )

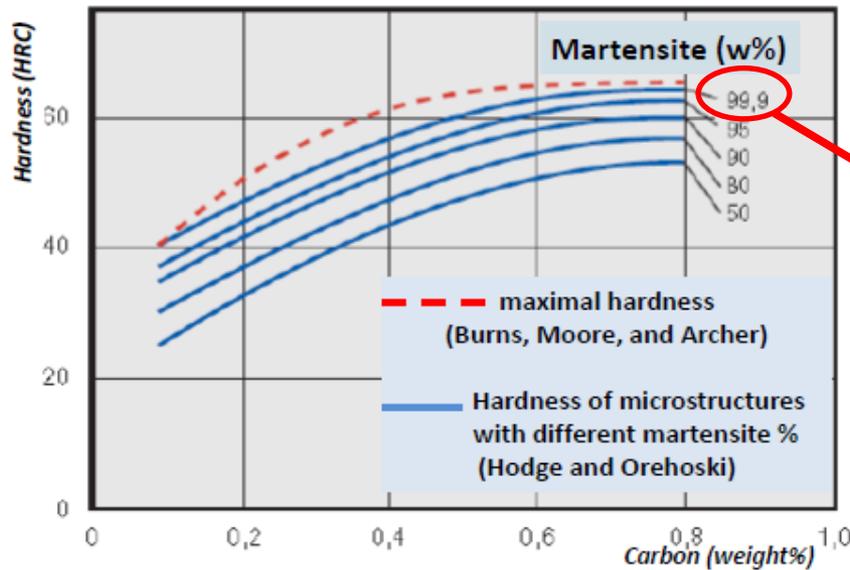


Martensite (hardened)

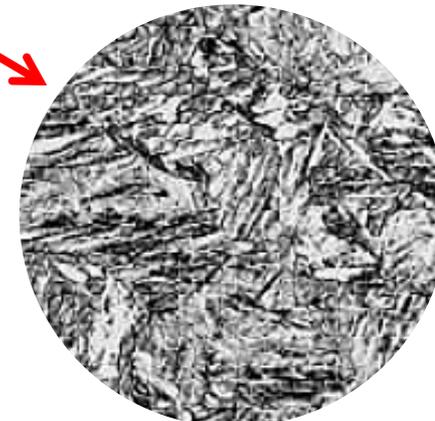


## Heat Treatments - Thermal Hardening

Achievable Maximal Hardness linked to the Carbon Content



*Fig 3. Photomicrograph of a cross section of an iron-cylinder showing hardened case profile and overlap region*



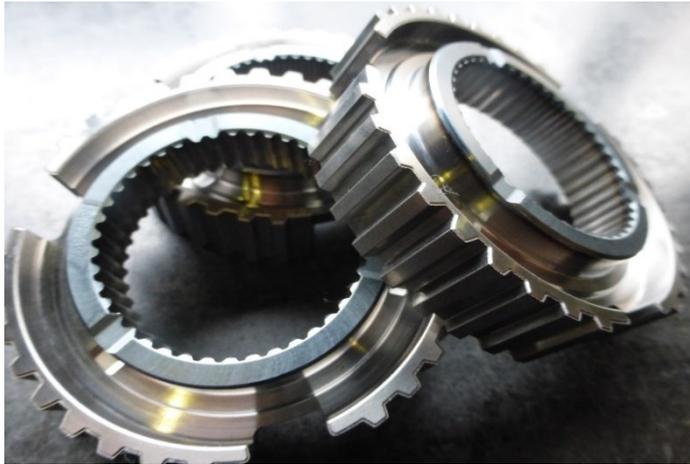
재질	고주파 열처리	레이저 열처리
S 35C	H R C 40~52	H R C 48~53
S 50C	H R C 55~62	H R C 59~63
SCM415	<b>부적합</b>	<b>부적합</b>
S C M 440	H R C 55~62	H R C 57~62
S K 5	H R C 55~65	H R C 60~65
S U J 2	H R C 58~65	H R C 60~65
S K D 11	H R C 55~60	<b>미흡</b>
F C D 600	H R C 45~52	H R C 50~60
S U S 420 J 2	H R C 45~55	H R C 45~50

Table 1 Relative response of selected common materials to laser transformation hardening

Excellent	Moderate	Poor
Medium-carbon steels	Low-carbon steels	Spheroidized steels
High-carbon steels	Pearlitic cast iron	Ferritic cast irons
Low-alloy steels	Cast steels	

# 변속기 DCT 싱크로 허브

보스 단면 만 레이저 열처리



택트 타임 단축, 비용 절감,  
냉각 오일 불필요,  
내경 치수 변화 극소

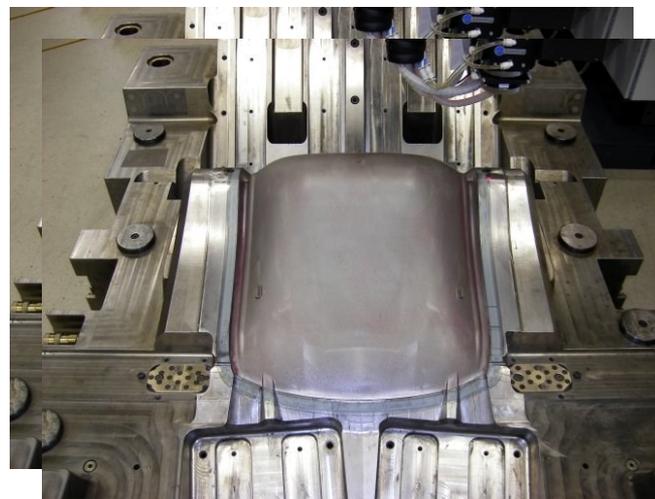
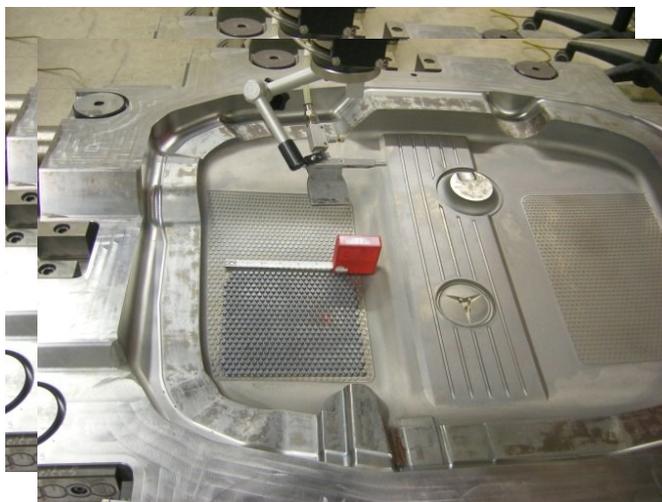
The screenshot shows the Jpma (Japan Powder Metallurgy Association) website. The main navigation bar includes 'TOPICS', '工業会について' (Industrial Association), '環境計画' (Environmental Plan), '製品・技術別情報' (Product/Technology Information), and '刊' (Publications). The page title is '工業会について' (About the Industrial Association). Below the title, there is a breadcrumb trail: 'Home > 工業会について - 工業会賞(平成26年度)'. A section titled '工業会賞のご紹介' (Introduction to Industrial Awards) highlights the '平成26年度' (Heisei 26th Year) awards. A list of award categories includes '新製品賞・デザイン部門' (New Product Award - Design), '新製品賞・材質部門' (New Product Award - Material), '新製品賞・製法開発部門' (New Product Award - Manufacturing Development), '原料賞' (Raw Material Award), '設備開発賞' (Equipment Development Award), and '奨励賞' (Encouragement Award). The '新製品賞・製法開発部門' category is selected, showing a specific award for 'レーザ焼入れ技術を適用したDCTシンクロハブの開発' (Development of DCT Synchronizer Hubs using Laser Heat Treatment Technology) awarded to '住友電気工業株式会社' (Sumitomo Electric Industries, Ltd.). The description mentions that the laser heat treatment technology was used to achieve high precision, cost reduction, and environmental friendliness, leading to high production performance and high expectations for future expansion.

※ 日本粉末冶金工業会HPより 平成26年度工業会賞

Mold making

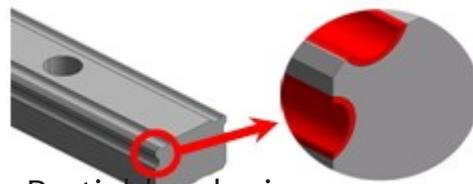


Mold making  
Partial hardening along the closing edge  
on the mold.

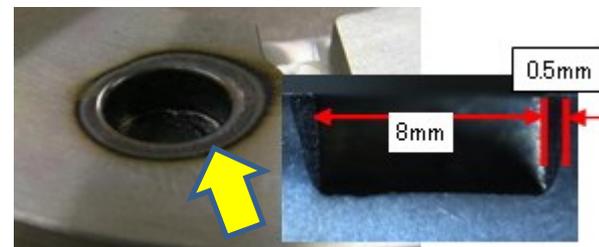




Cylinder inside. Low distorted hardening  
Deformation after hardening :  $3\mu\text{m}$



Partial hardening  
It is possible to hardening marked parts



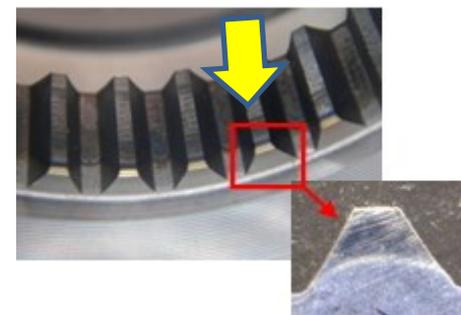
Small diameter hole (Inside hardening)  
It is possible to hardening very small hole side.



Pipe inside diameter hardening  
It is possible to hardening spirally.



Groove portion hardening  
Hardening for side and bottom of groove.



Internal gear hardening  
Hardening for top of gear

**주철 금형 · 프레스 금형**

**기어류 · 레일류**

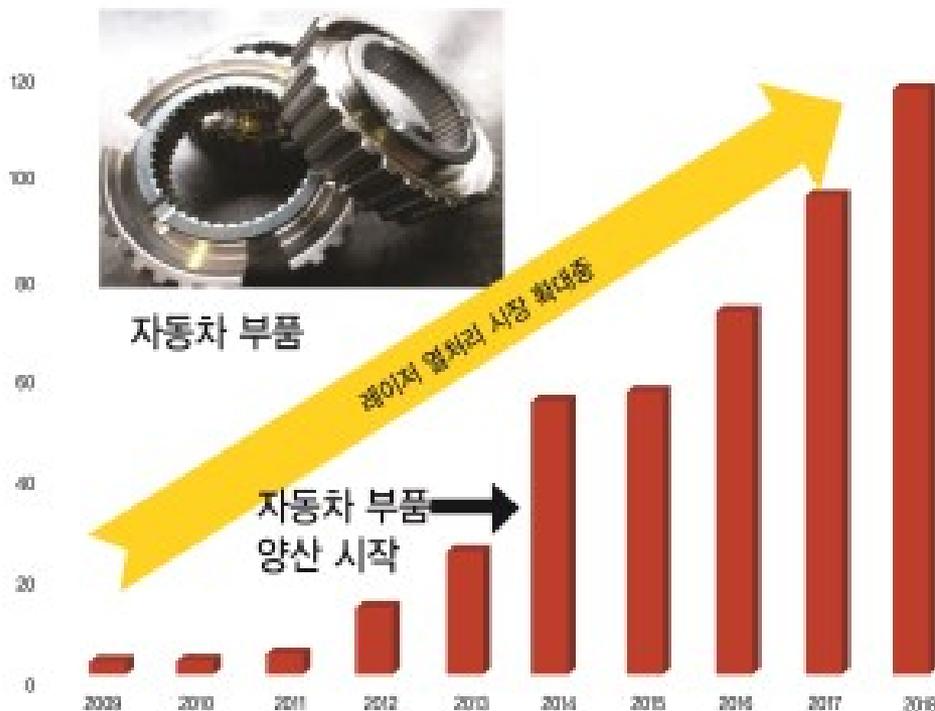
**링류 · 자동차부품**

**산업기계부품 등**

비용절감  
수명증대

다양한  
적용부품

### 레이저 열처리 시장 성장 추이



# Thank You !

**레이저 열처리 공장 견학 프로그램 신청 접수 중!**

시작품 개발 및 공장 견학 문의 환영합니다.

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