TowerSeating
CONTRACT MANUFACTURER

BAOSTEEL 宝钢股份 | 构 筑 共 享 价 值

Advanced High Strength Steels (AHSS) in BAOSTEEL

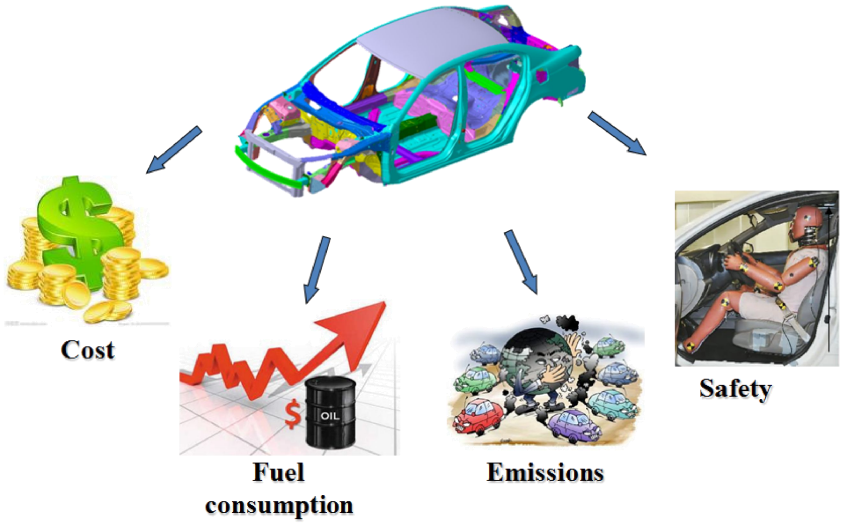
R&D Centre, BAOSTEEL
June 20, 2014

Contents

● AHSS: one of the most important development directions of automotive materials

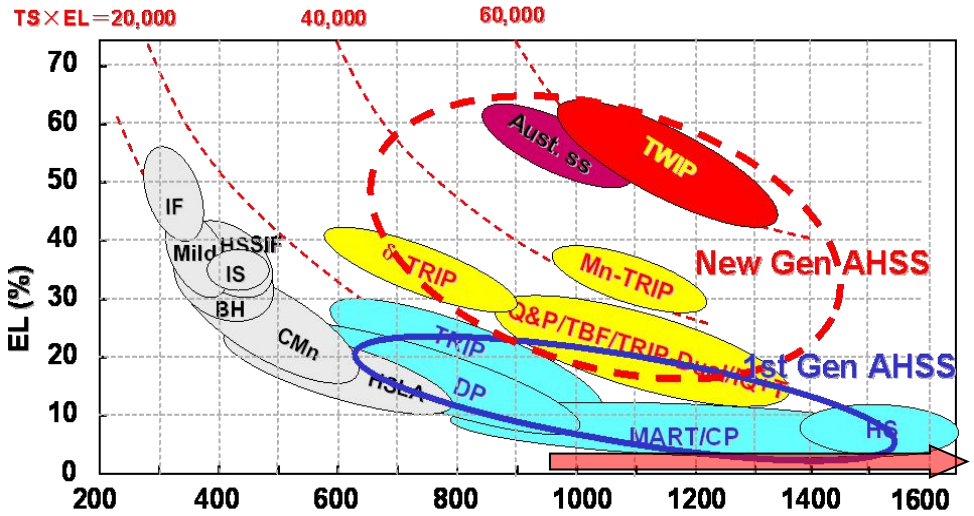
➢New materials

➢New technologies



●Focus of R&D:

- ➢ Materials: Higher strength, better formability
- ➢ Application technology: Forming, Welding, Painting



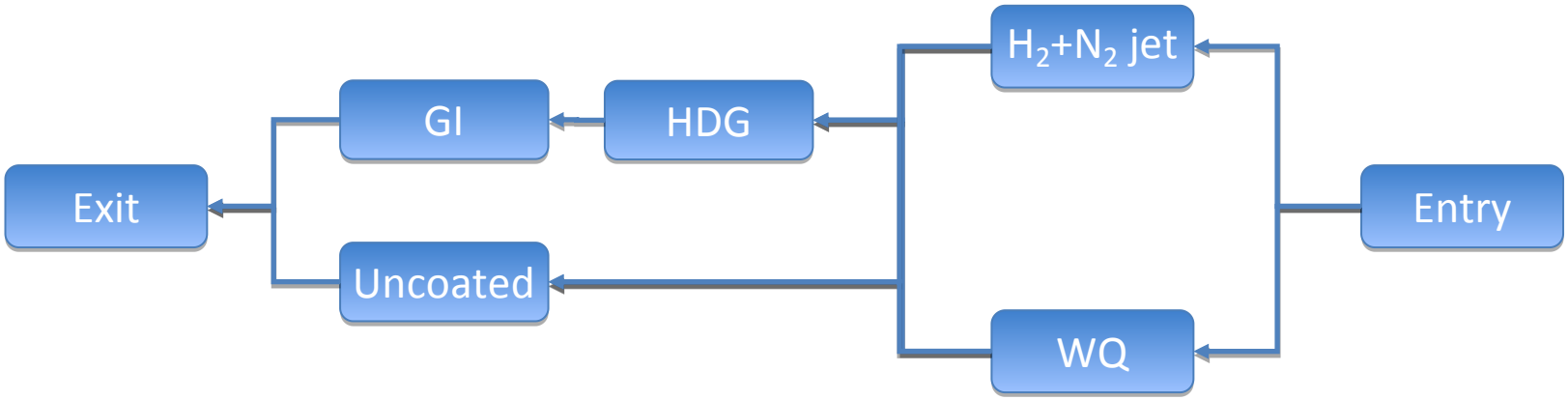
2nd Gen AHSS

3rd Gen AHSS

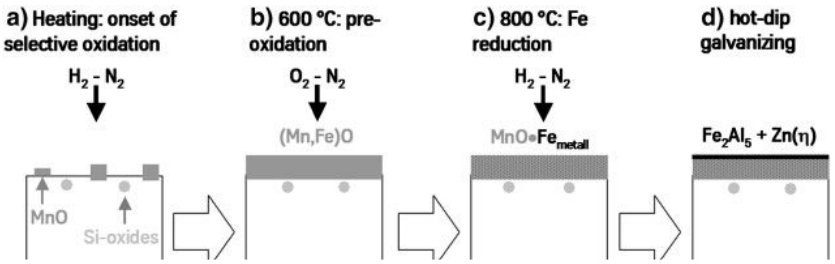
1st Gen AHSS

New Gen AHSS

CAL/GI line for UHSS of BAOSTEEL

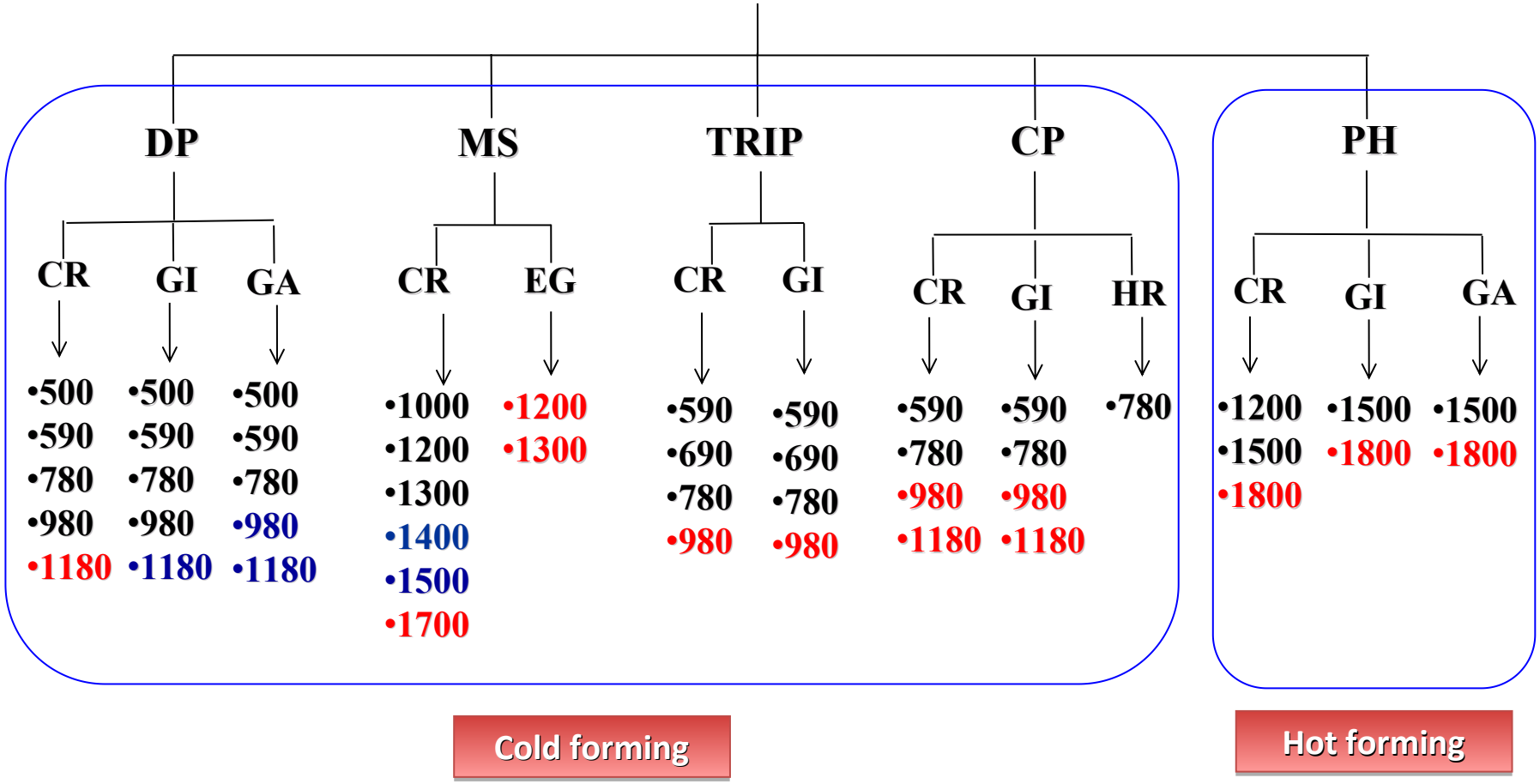


- **Facility: A specially designed CAL line for UHSS was launched in march 2009**
  - ➢ **Flexible line: Multi-purpose switch**
    - ✓ **Varieties: Uncoated or GI**
    - ✓ **Cooling medium: H_2+N_2 or water**
  - ➢ **Innovative GI technology: pre-oxidation**



Contents

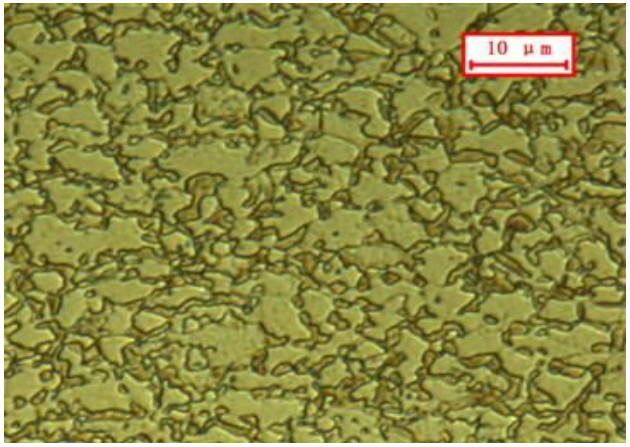
Main grades of 1st-Gen AHSS in BAOSTEEL



Black: Commercial; Red: Developing; Blue: Trail production

●Dual phase (DP) steels

➢ Products microstructure and properties



Steel grade	YS, MPa	TS, MPa (minimal)	El, % (minimal)	Availability
HC280/590DP	280～380	590	22	Yes
HC340/590DP	340～440	590	20	Yes
HC550/690DP	550～660	690	12	Yes
HC420/780DP	420～550	780	14	Yes
HC500/780DP	500～650	780	10	Yes
HC550/980DP	550～730	980	7	Yes
HC700/980DP	700～900	980	7	Yes
HC820/1180DP	820～1130	1180	3	Prototype

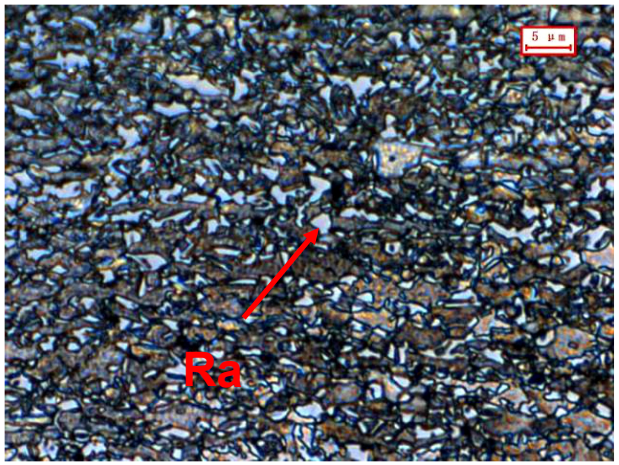
➢ Application cases: Good comprehensive properties, suitable for press forming of most auto-parts of BIW

Bumper,
HC700/980DP (thickness: 1.6mm)

Door beam,
HC550/980DPD+Z (Coating thickness: 50/50g/m2, thickness: 1.2mm)

●TRansformation induced plasticity (TRIP) steels

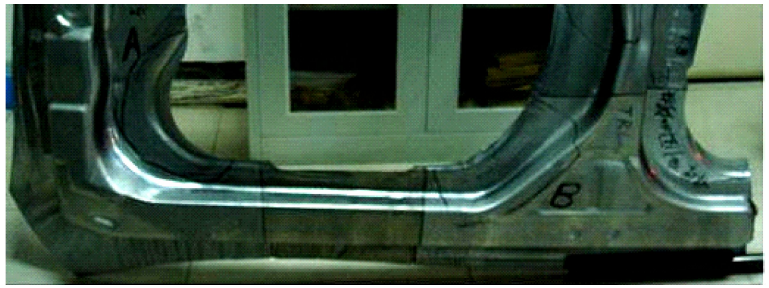
➢ Products microstructure and properties



Steel grade	YS, MPa	TS, MPa (minimal)	EL, % (minimal)	Availability
HC380/590TR	380~480	590	29	Yes
HC400/690TR	400~520	690	24	Yes
HC420/780TR	420~580	780	20	Yes
HC450/980TR	450~700	980	14	QP980

➢ Application cases: Good ductility, suitable for press forming of complex shape parts

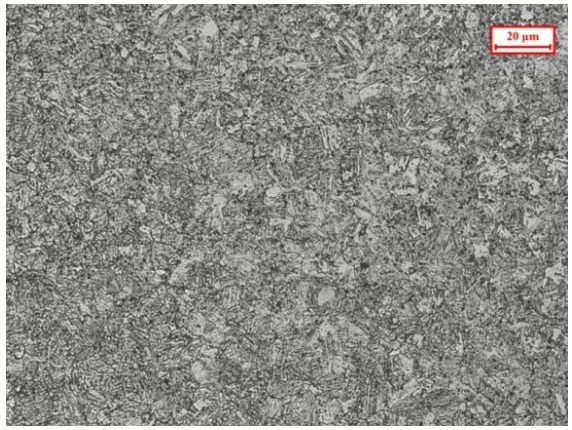
B-pillar reinforcement,
HC420/780 (Thickness: 1.8mm)



Side panel reinforcement, TWB
HC420/780 (Thickness: 1.6mm)

●Complex phase (CP) steels

➢ Products microstructure and properties



Steel grade	YS, MPa	TS, MPa (minimal)	EL, % (minimal)	Availability
HC350/600CP	350~500	600	16	Yes
HC500/780CP	500~700	780	10	Yes
HD680/780CP (CR, HR)	680~830	780	10	Yes
HC700/980CP	700~900	980	7	**Prototype**

➢ Application cases: **Auto parts produced by roll forming, flanging, and hole expansion, etc.**

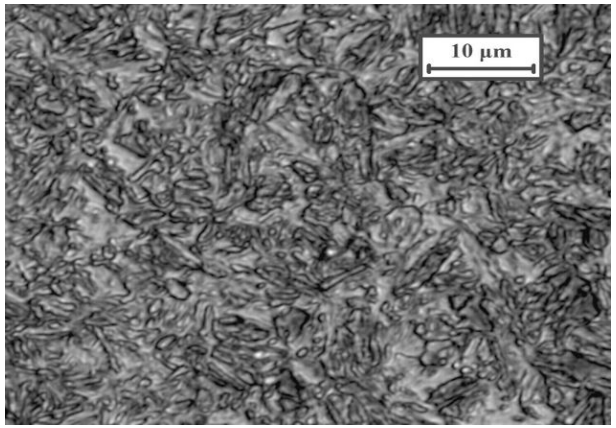
➢ Characters

- ✓ **Ultrahigh strength**
- ✓ **Higher yield ratio: ~0.9**
- ✓ **Better bendability**
- ✓ **Good Stretch flangeability**

Seat rails, HC700/980CP

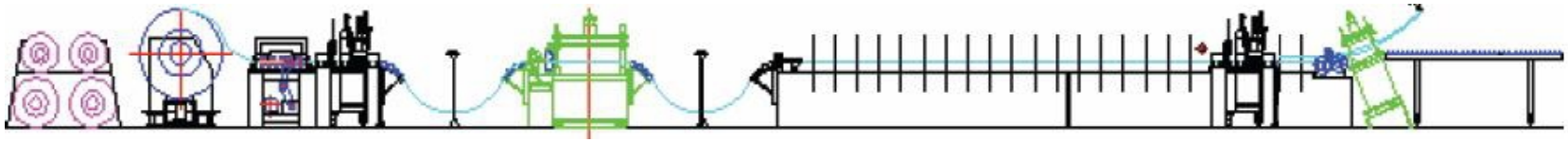
●MS (Matensitic steels)

➢ Products microstructure and properties

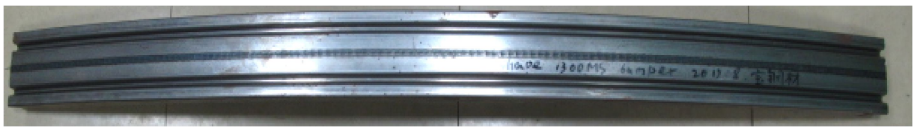


Steel grade	YS, MPa	TS, MPa	EL, %	Availability
HC700/980MS	830	1020	7	Yes
HC950/1180MS	1050	1270	6	Yes
HC1030/1300MS	1100	1350	5	Yes
HC1150/1400MS	1200	1450	4	Prototype
HC1200/1500MS	1300	1550	4	Prototype

➢ Application cases: roll forming or press forming of simple parts



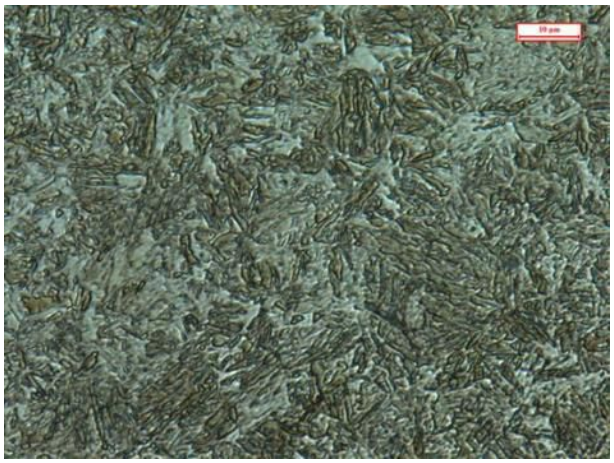
Rear bumper,
HC700/980MS (thickness: 1.6mm)



Rear bumper,
HC1030/1300MS (thickness: 1.6mm)

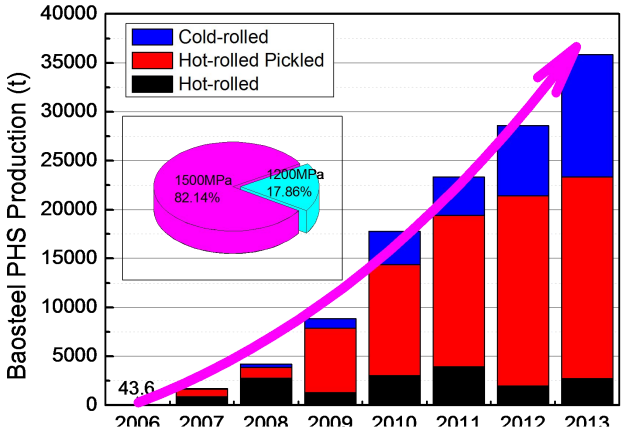
●Press Hardening (PH) steels - uncoated

➢ Products microstructure and properties



Steel grade	YS, MPa	TS, MPa	EL, %	Availability
BR1200HS	⩾280	⩾700	⩾18	Yes
B1200HS	⩾220	380 ~ 700	⩾22	Yes
1200*	900 ~ 1200	⩾1200	⩾7	
BR1500HS	320～630	480～800	⩾16	Yes
B1500HS	280～450	⩾450	⩾20	Yes
1500*	950～1250	1300～1800	⩾5	
B1800HS	⩾1100	⩾1800	⩾4	June, 2014

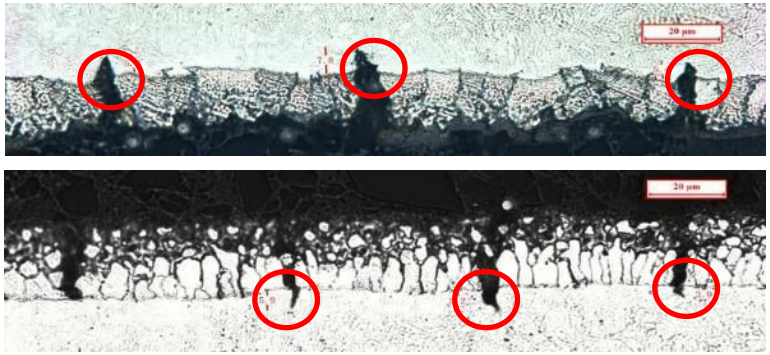
➢ Application cases: hot press forming of the parts with complex shape

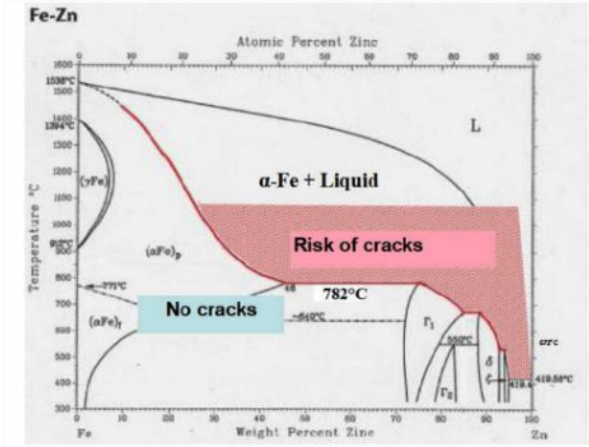


B-pillar
B1500HS (Thickness: 1.8mm)

●Press Hardening (PH) steels – Zn coated

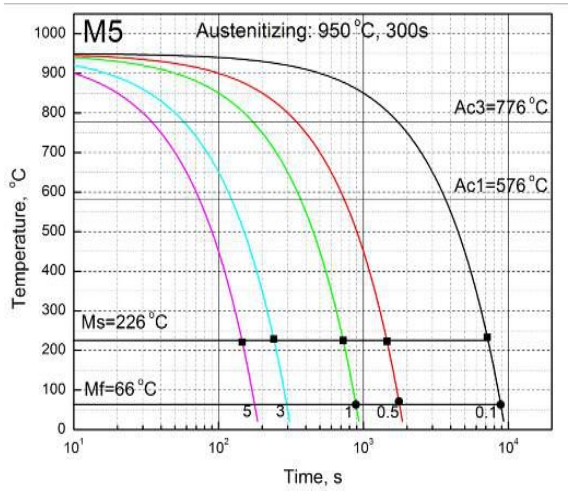
LME（Liquid Metal Embrittlement）





Potential solution

- ✓ **Lower strain: Indirect hot stamping**
- ✓ **Lower austenite temperature: New materials**



New PH steel by BAOSTEEL

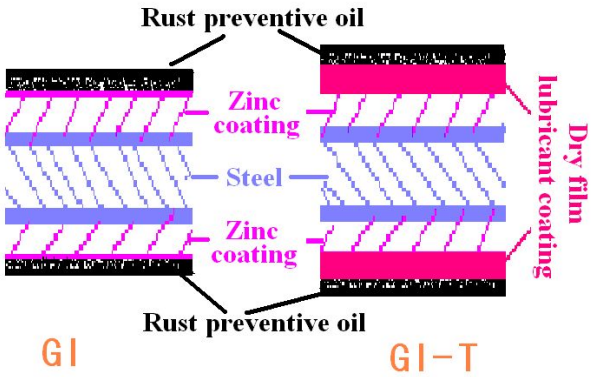
Ac_3: 750~800℃

YS, MPa	TS, MPa	EL, %
953	1,800	10.7

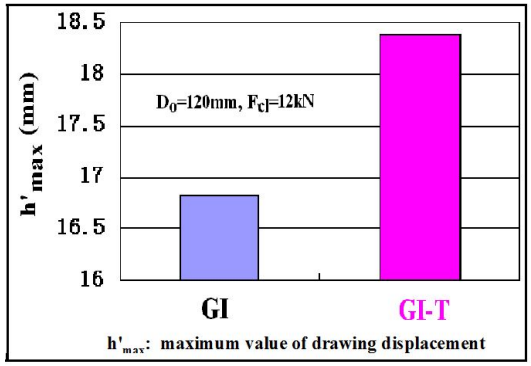
Prototype available by June, 2015

● GI-T: Inorganic dry film lubricant coated galvanized steel sheet

➢ Structure and properties of GI-T products



oil type	A	B	C
GI	0.144	0.135	0.126
GI-T	0.107	0.106	0.093
decrease of μ(%)	25	21	26



➢ Advantages of GI-T

- ✓ Lower friction coefficient
- ✓ Improved stamping behavior
- ✓ Reducing the die cleaning frequency
- ✓ Excellent spot weldability
- ✓ Good phosphate compatibility


hood inner

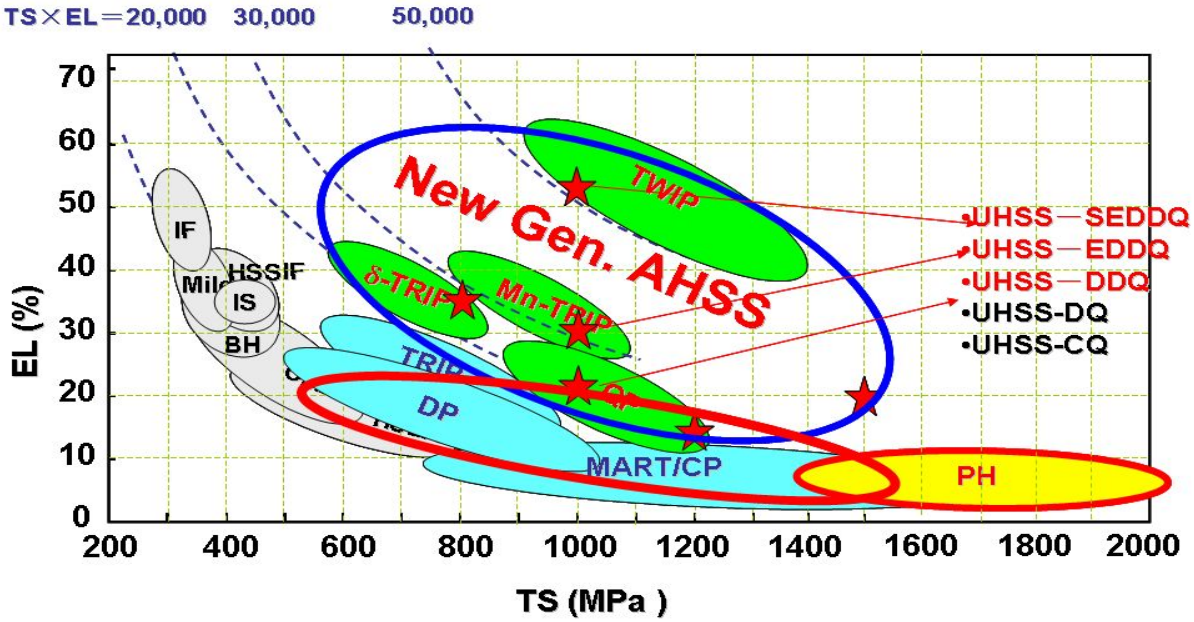

door inner


side panel


luggage compartment floor

Contents

Ultra-high strength + improved ductility



New Gen AHSS in BAOSTEEL

Q&P(DDQ)

CR	GI
•980	•980
•1180	•1180
•1300	•1300

Mn-TRIP(EDDQ)

CR	GI
•980	•980
•1180	•1180

TWIP(SEDDQ)

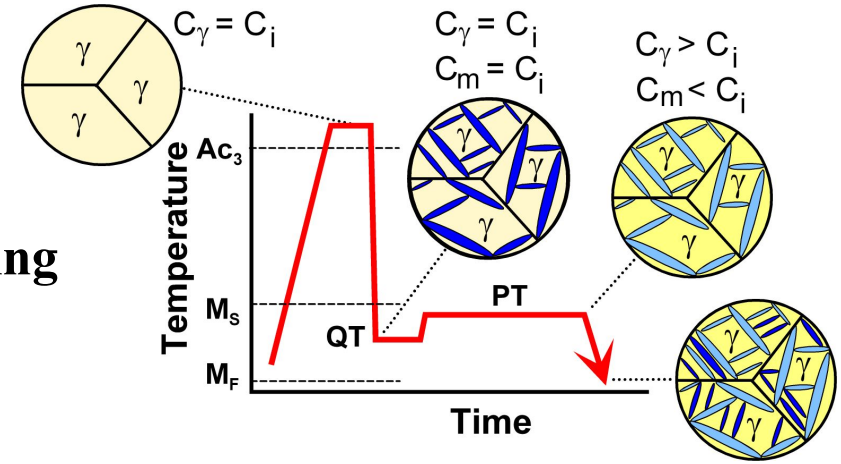
CR	GI
•980	•980
•1180	•1180

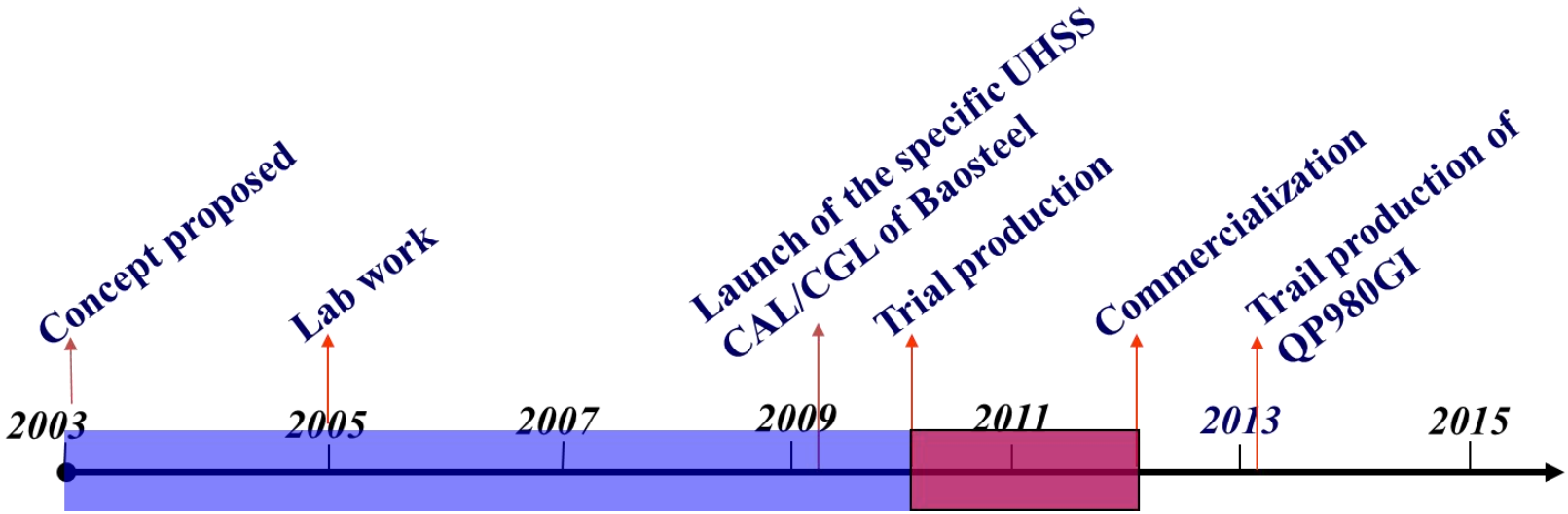
δ-TRIP(EDDQ)

CR	GI
•590	•590
•780	•780
•980	•980

●Concept and history

- ➢Concept：Prof. J Speer
- ➢Q&P：Quenching and partitioning
- ➢Technique：one step & two step
- ➢Industrialization ： world first





**Speer JG, Matlock DK, De Cooman BC, Schroth JG. Carbon partitioning into austenite after*

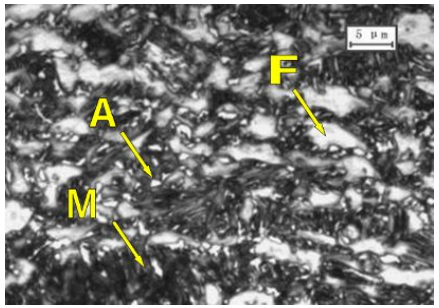
● Characters of Q&P steels

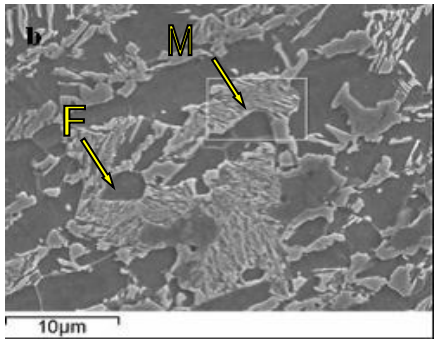
- ➢ **Chemical compositions (wt.%)**
- ➢ **Products available**

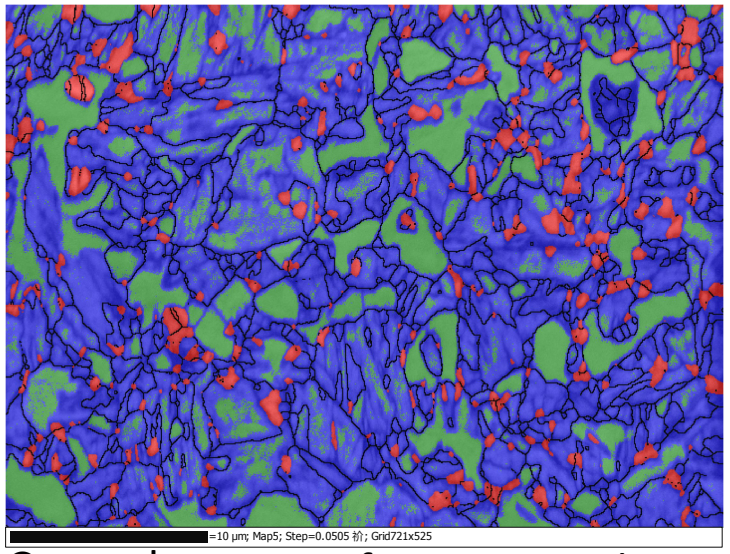
C	Mn	Si
~0.2	<3.0	<2.0

  - ✓ **Dimension：(Thickness: 1.0～2.1)×(width: 700～1250)mm**
  - ✓ **Type：CR / HDG**

- ➢ **Microstructure：**
  - ✓ **Martensite (~70%)**
  - ✓ **Ferrite (~20%)**
  - ✓ **Retained austenite (~10%)**







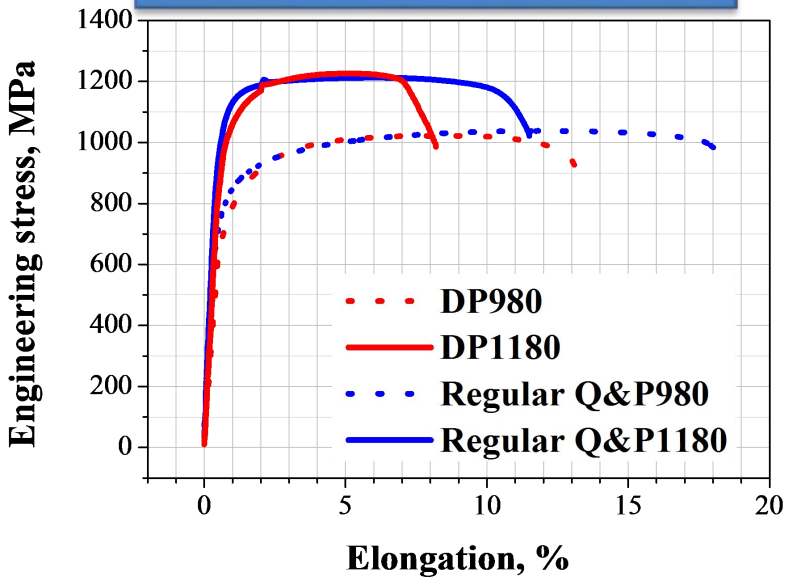
Green: bcc (F)　RED: fcc (γ)　BLUE: bcc (M)

●Two families of Q&P steels with different ductility

Regular Q&P

Steel Grade	YS(MPa)	TS(MPa)	EL (%)
980	650~800	980~1050	15~20
1180	950~1150	1180~1300	8~12

Commercialized

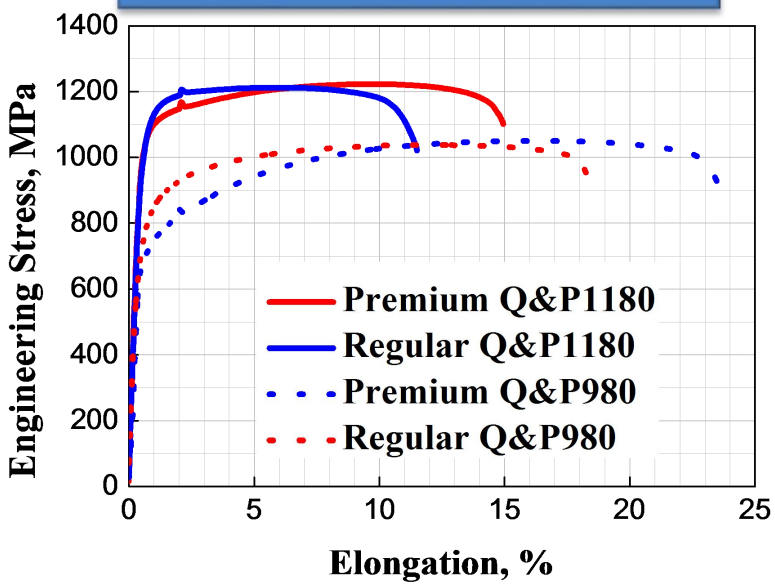


For upgrading from

Premium Q&P

Steel Grade	YS(MPa)	TS(MPa)	EL (%)
980	550~750	980~1050	21~25
1180	850~1050	1180~1300	14~18

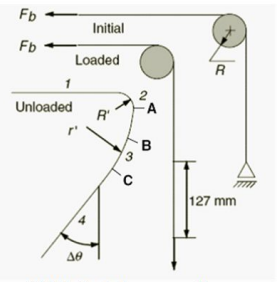
Prototype available

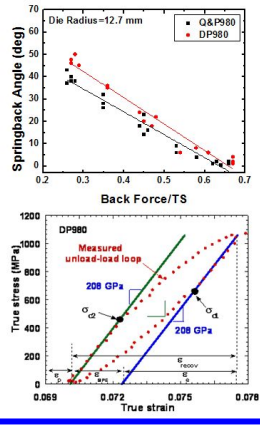


Providing an alternative

➢ Properties evaluation of commercialized Q&P steels

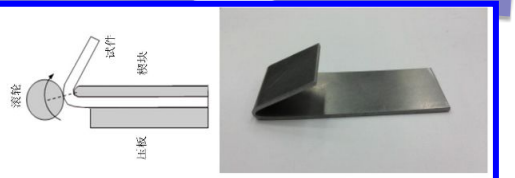
Spring back





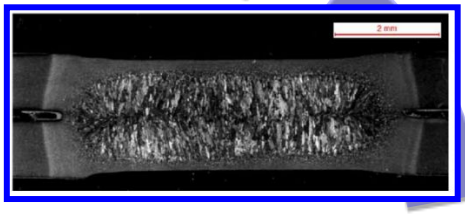
Q&P steels have smaller spring-back angles than DP steels at the same strength level and bend radius, due to their pseudo-elastic behaviors.

Bending

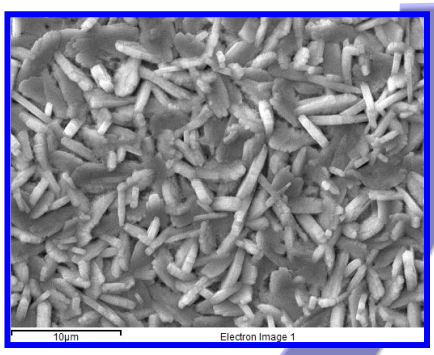


材料		DP590	DP780	DP980	QP980	QP980
板厚(mm)		1.6	1.5	1.8	1.6	1.2
$(r/t)_{min}$	RD	≤0.4	≤0.4	0.7	0.6	0.6
	TD	≤0.4	0.5	1.0	0.6	0.6

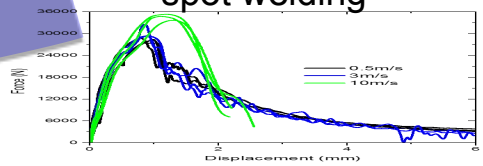
Welding



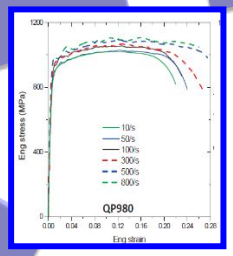
Phosphatizing



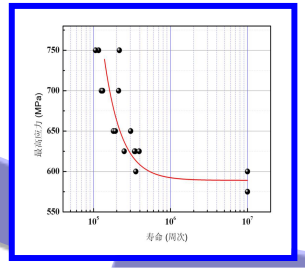
Dynamic test for spot welding



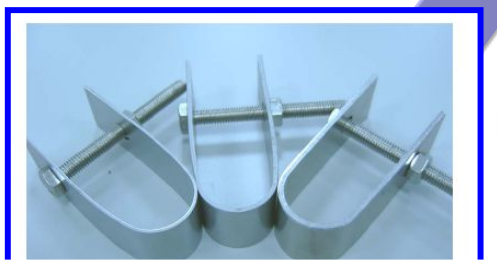
Dynamic fracture



Fatigue



HER



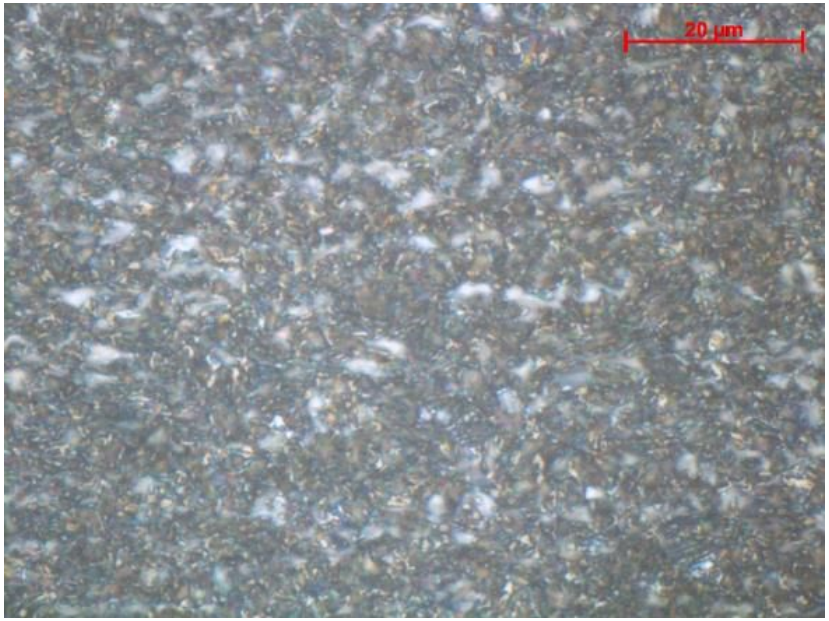
Delayed Fracture

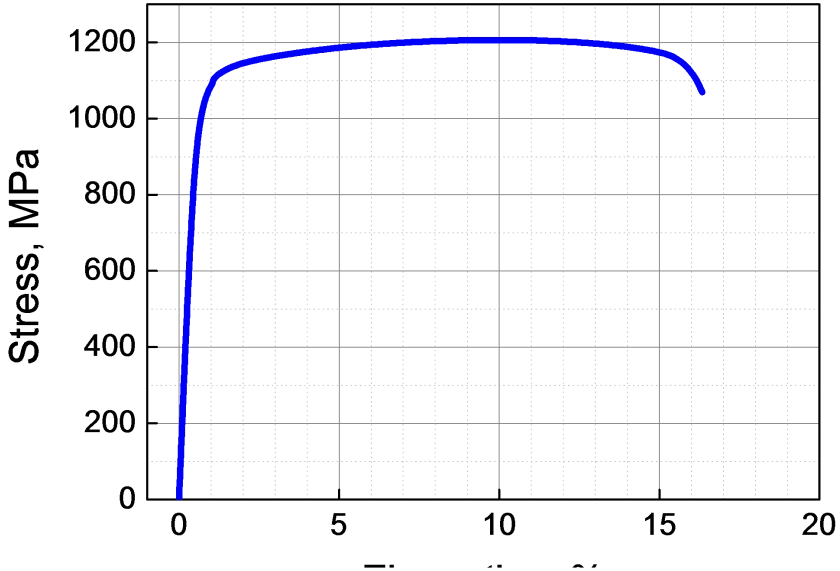
Prototype of Premium QP1180-CR

Mechanical properties	YS MPa	TS MPa	UEL %	EL %	HER %	R/t
HE1180-CR	1006	1206	9.4	15.8	46	1.5

Gauge (mm):

1.0×1100×C

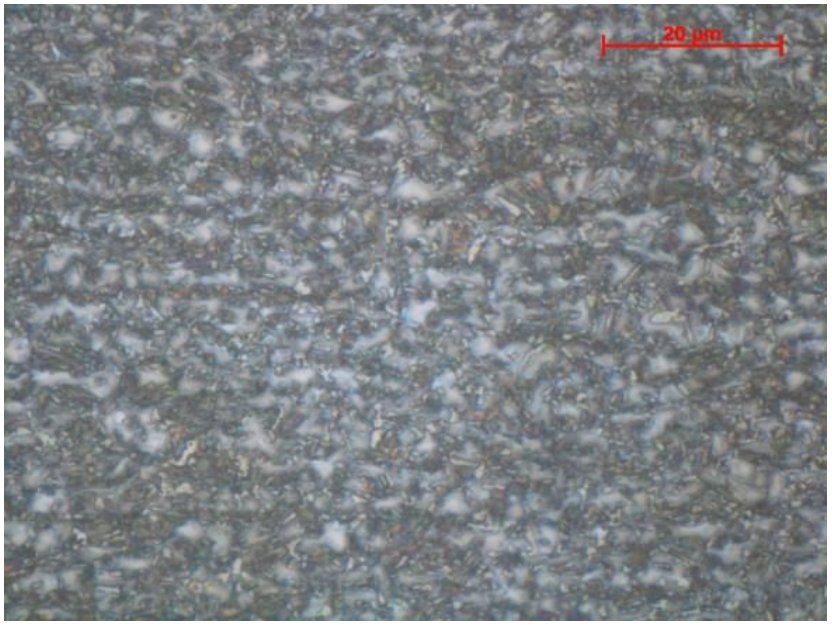




Prototype available

Prototype of Premium QP980-CR

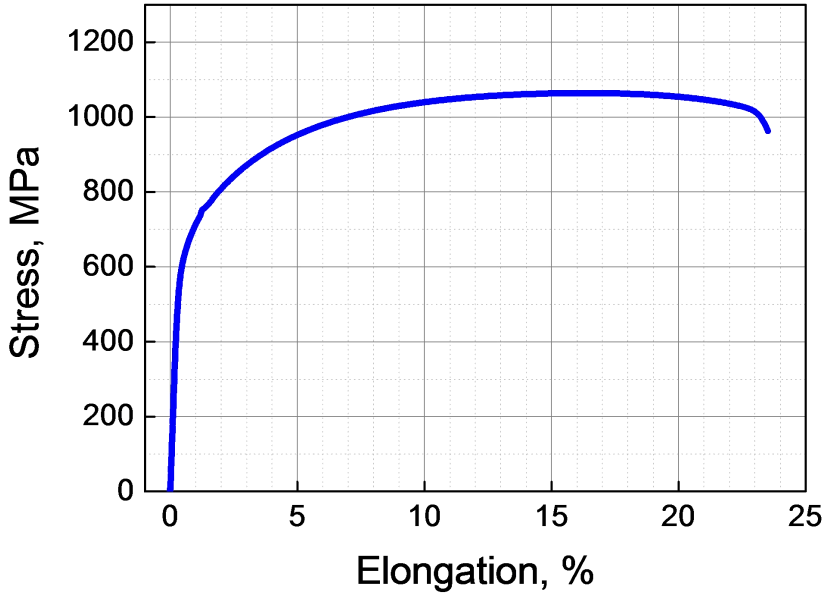
Mechanical properties	YS MPa	TS MPa	UEL %	EL %	HER %	R/t
HE980-CR	665	1041	15.4	22.4	41	1.5



Prototype available

Gauge (mm):

1.0/2.0×1100×C

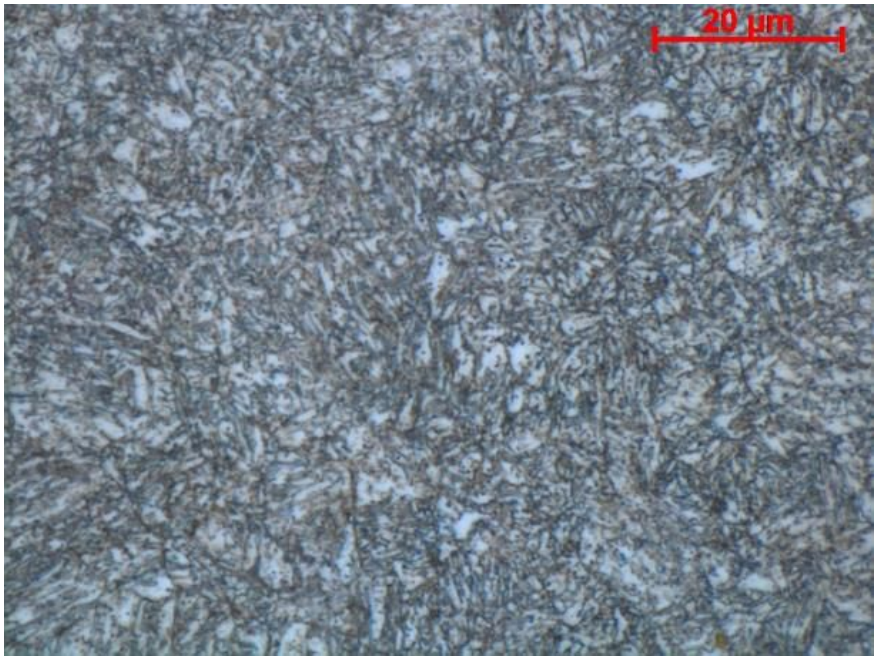


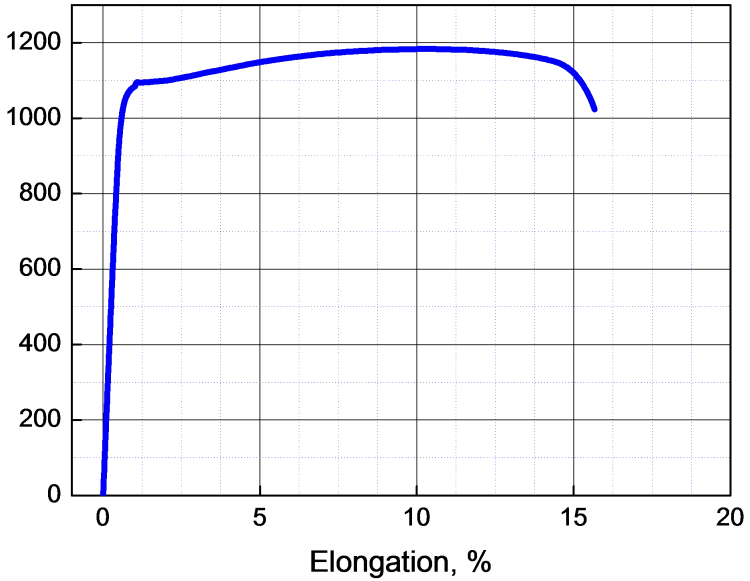
Prototype of Premium QP1180-GI

Mechanical properties	YS MPa	TS MPa	UEL %	EL %	HER %	R/t
HE1180-GI	1054	1192	10.1	16.0	40	1.5

Gauge (mm):

1.2×1100×C





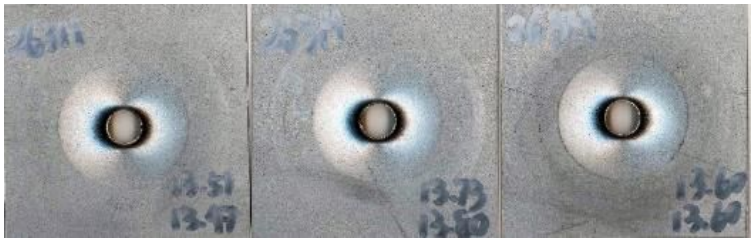
Prototype available

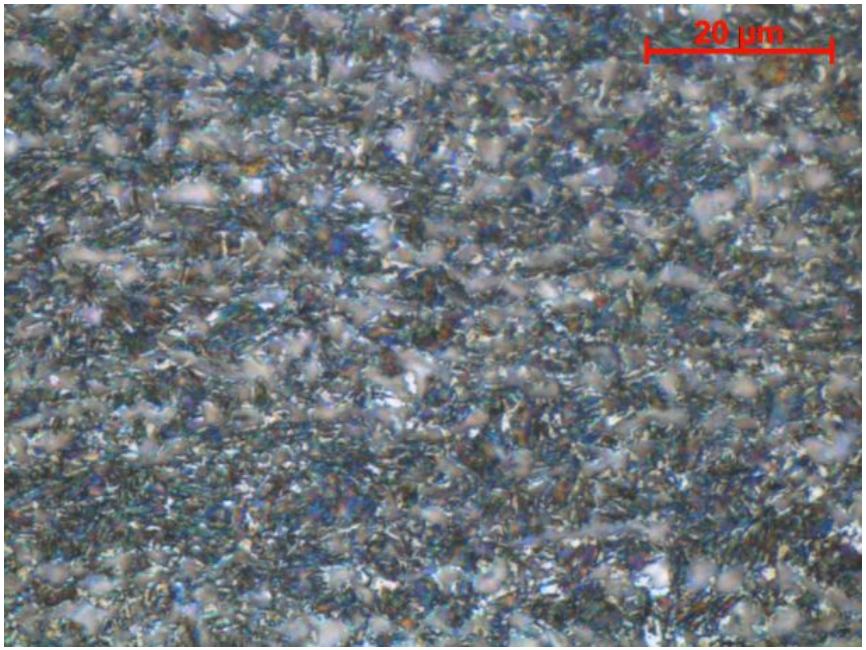
Prototype of Premium QP980-GI

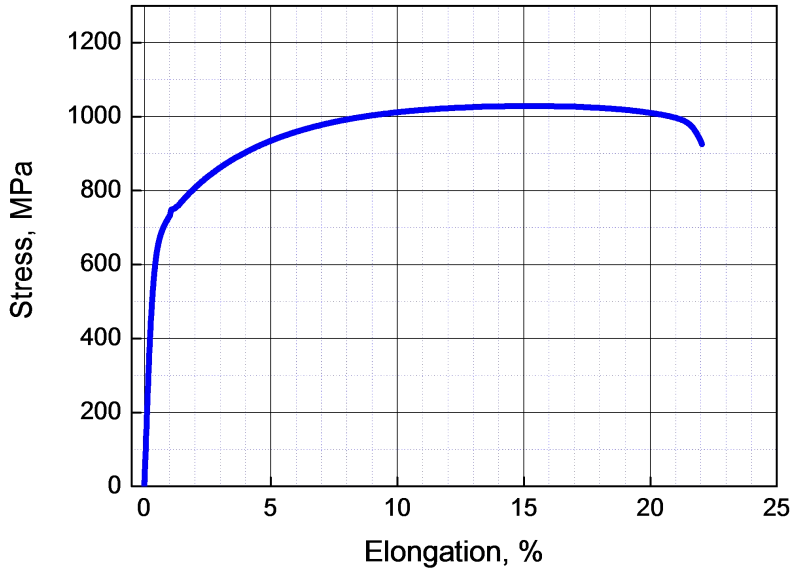
Mechanical properties	YS MPa	TS MPa	UEL %	EL %	HER %	R/t
HE980-GI	653	1048	14.8	22.0	36	1.5

Gauge (mm):

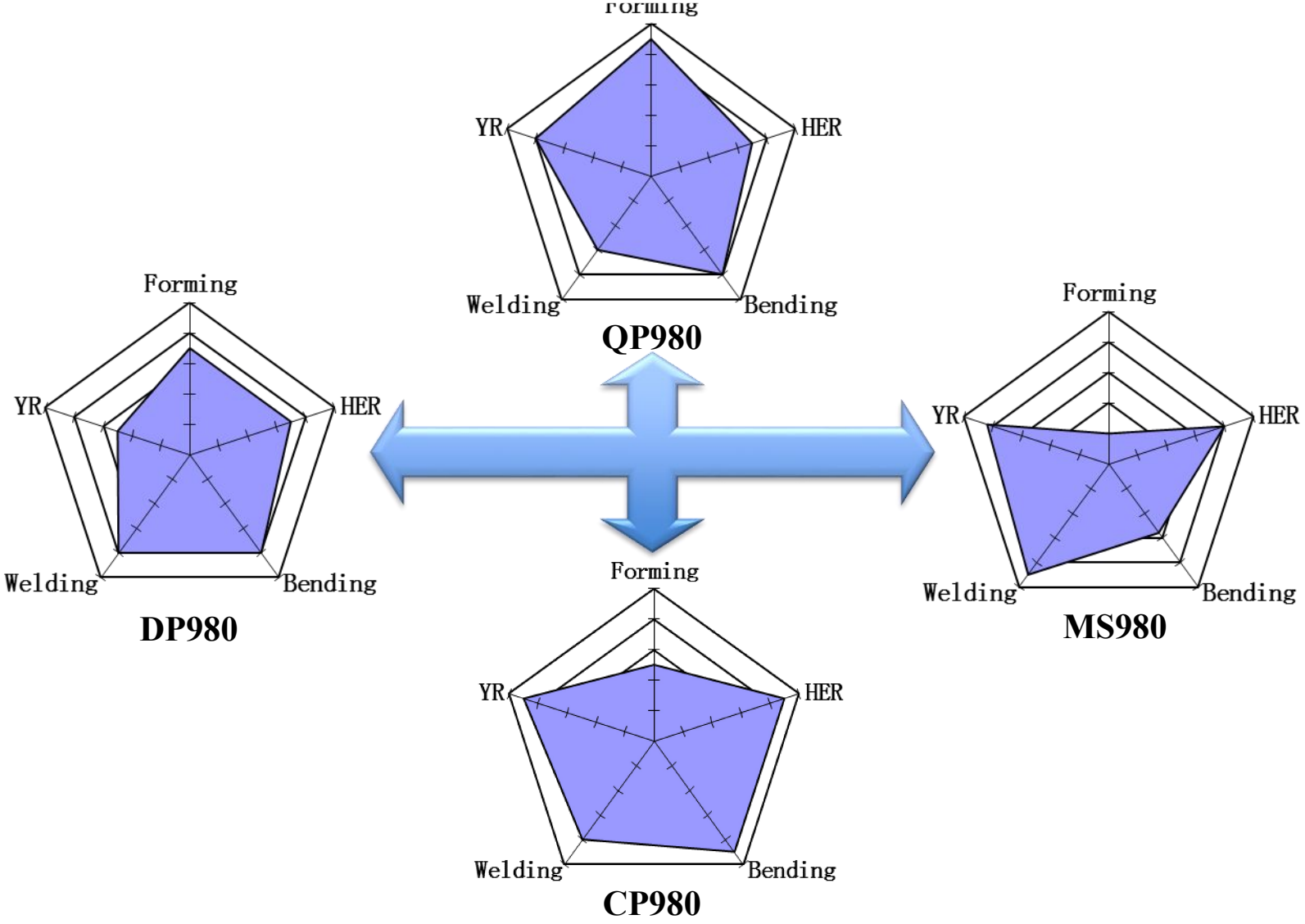
1.0×1100×C





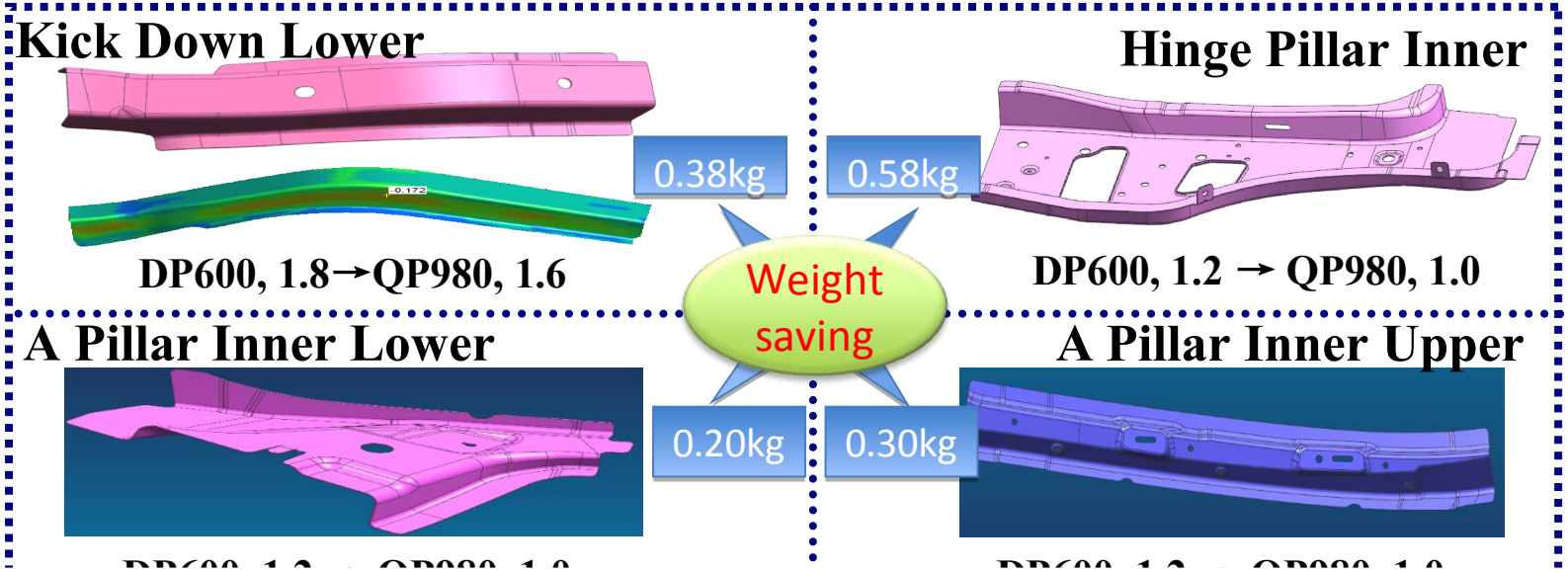


Prototype available



Right materials at right place

B pillar reinforcement of a self-owned brand car



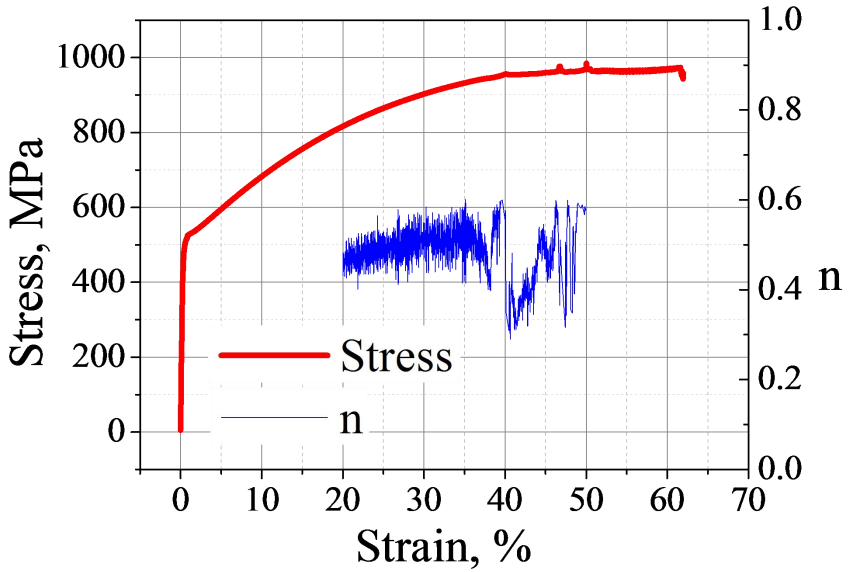
●TWIP (Twinning Induced Plasticity)

✓Full austenite microstructure: **Austenite-stabilizing elements**

✓Superior strain hardening capability

➢ Target chemical composition (wt.%):

C	Mn	Al	X
0.5~1.0	14~18	1.5~2.5	~



●Focus of R&D:

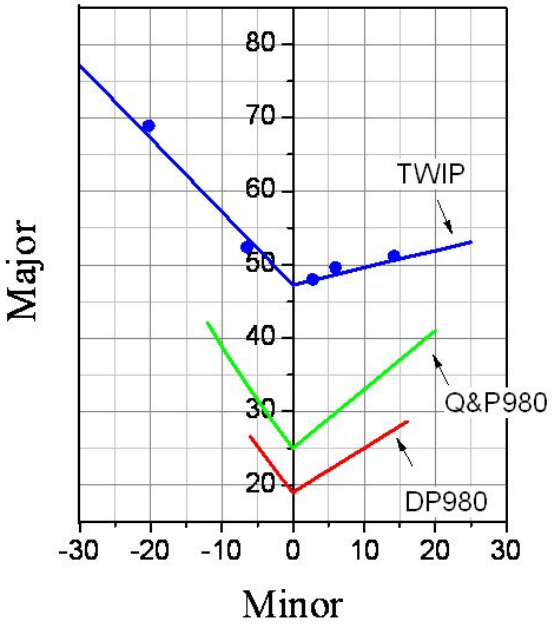
- ➢ Materials: Higher strength
- ➢ Galvanizing

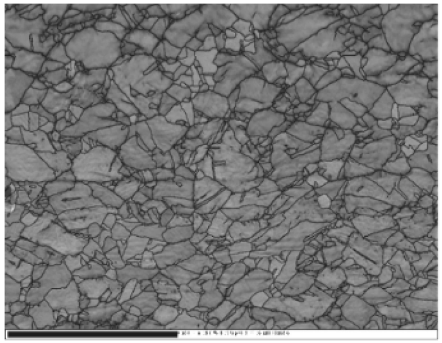
Grade	TS，MPa	EL，%	Type	Availability
TWIP1000	≥980	≥45	Uncoated	Prototype
TWIP1000GI	≥980	≥45	Zn-coated	Prototype
TWIP1200	≥1180	≥35	Uncoated/Zn	By next June

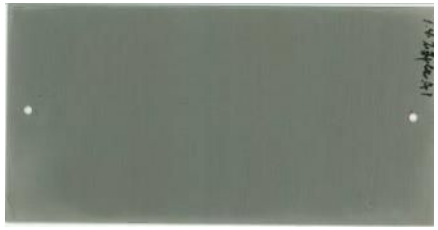
R&D of TWIP steel

Uncoated

Galvanized







TowerSeating
CONTRACT MANUFACTURER

●Medium Mn TRIP

➢ Chemical composition

Element	C	SI	Mn
Content	0.10~0.4	0~1.0	5.0~10.0

➢ Mechanical properties

YS(MPa)	TS(MPa)	EL (%)
>800	>1000	>30

➢ Technique procedure

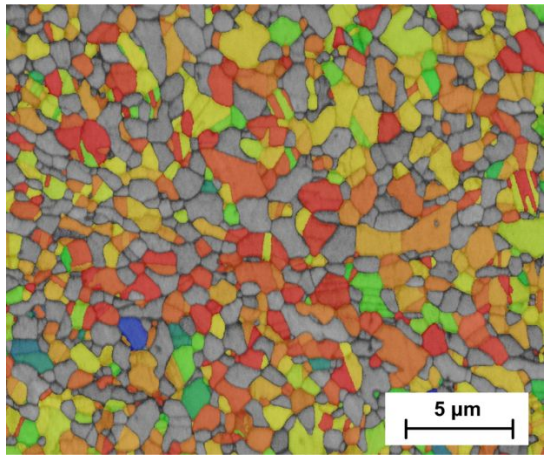
✓ Austenite revert transformation

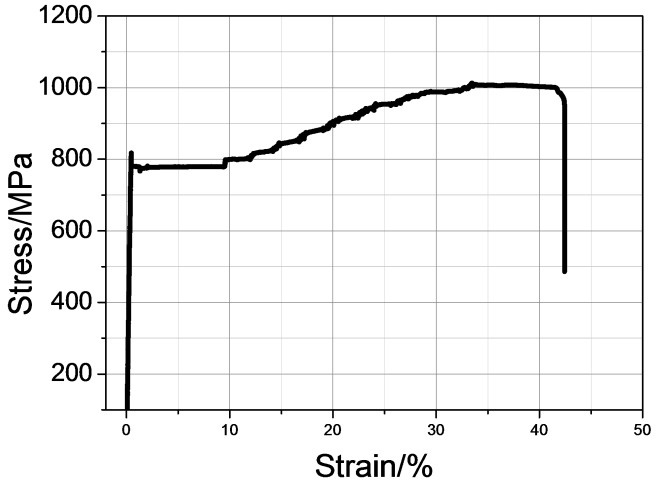
➢ Mechanical Properties (lab work)

YS (MPa)	TS (MPa)	UEL (%)	EL (%)	TS×EL MPa%
781	1013	33.5	42.4	42951

Dimensions:
Width: 1230 mm;
Thickness: 1.4 mm

Ultra-fine Ferrite + Retained austenite

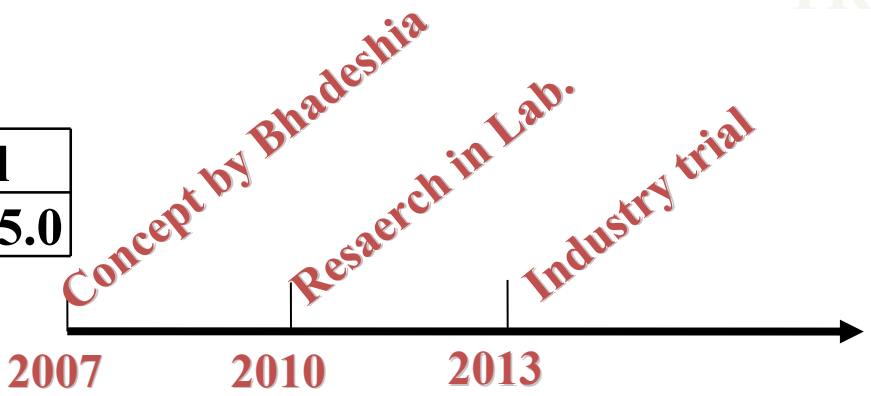




Prototype available

➢ Chemical composition

Element	C	SI	Mn	Al
Content	0.20~0.5	0.3~0.5	1.0~1.5	3.0~5.0

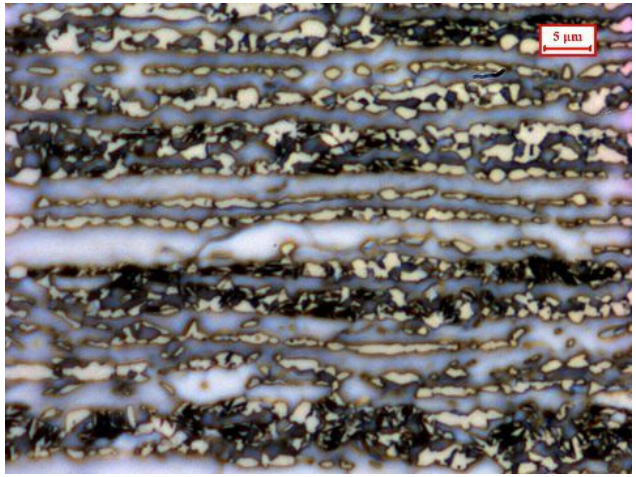


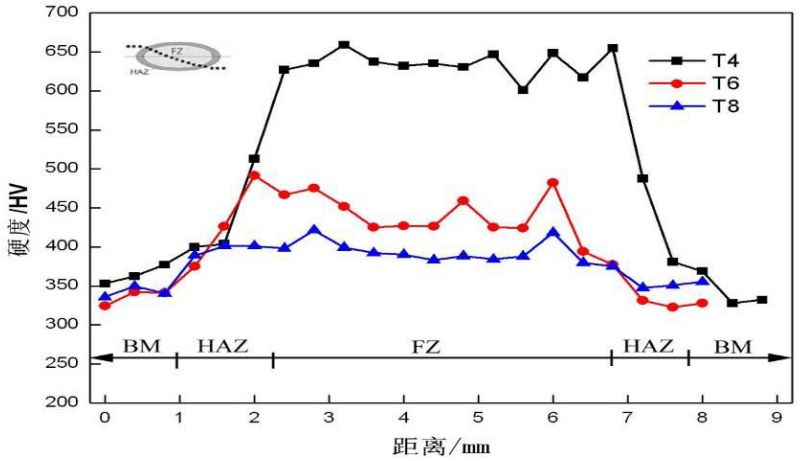
● δ -TRIP

①High EL

②Good weldibality

③Low Density





No.	YS	TS	EL
δ-TRIP780	~500	~800	~35%
TRIP780	~470	~800	~26%

Prototype available by June, 2015

Contents

Concluding Remarks

1. Mass application of AHSS in BIW is one of the most promising material solution of future vehicle.
2. BAOSTEEL can provide large varieties of Auto steel sheets, ranging from 1st AHSS to 3rd AHSS.
3. BAOSTEEL needs the collaboration and support of customers to promote the application of these newly developed AHSS products.