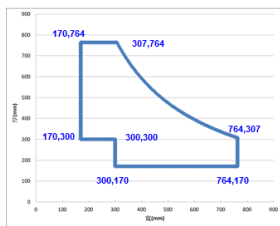




Advanced Plastic Mold Steel TS-GPA1


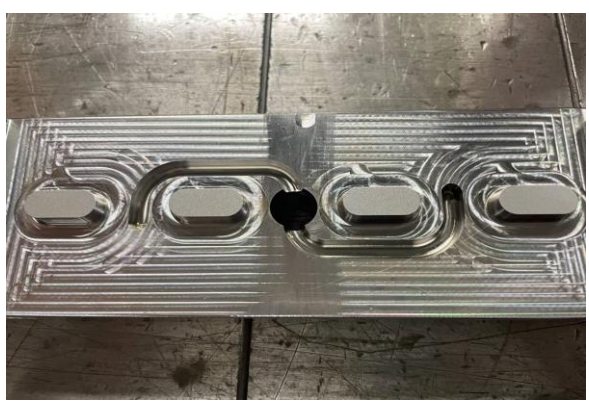
1. The grade of tool steels & chemical composition : (wt %)

(1) Brand	Grade	C	Si	Mn	P	S	Ni	Cr	Mo	V
TS	GPA1	0.22	0.15	1.30	Max	Max	1.00	1.00	0.40	0.10
		-0.32	-0.40	-1.60	0.030	0.003	-1.50	-1.50	-0.80	-0.30

2. General application & stock availability :

(2) Features and Application	(3) Size Capability & Hardness																																																																																																												
<ul style="list-style-type: none"> ● No heat treatment needed ● Excellent hardness homogeneity ● Good polishability ● Stable photo-etchability ● Optimal weldability <p>Used at large plastic mold</p>	<p>Hardness: 350-400HB</p>  <table border="1"> <thead> <tr> <th>W</th> <th>T max</th> <th>W</th> <th>T max</th> <th>W</th> <th>T max</th> </tr> </thead> <tbody> <tr><td>764</td><td>307</td><td>600</td><td>395</td><td>430</td><td>552</td></tr> <tr><td>760</td><td>309</td><td>590</td><td>402</td><td>420</td><td>565</td></tr> <tr><td>750</td><td>313</td><td>580</td><td>409</td><td>410</td><td>578</td></tr> <tr><td>740</td><td>318</td><td>570</td><td>416</td><td>400</td><td>592</td></tr> <tr><td>730</td><td>322</td><td>560</td><td>424</td><td>390</td><td>607</td></tr> <tr><td>720</td><td>327</td><td>550</td><td>431</td><td>380</td><td>623</td></tr> <tr><td>710</td><td>332</td><td>540</td><td>439</td><td>370</td><td>639</td></tr> <tr><td>700</td><td>337</td><td>530</td><td>448</td><td>360</td><td>656</td></tr> <tr><td>690</td><td>342</td><td>520</td><td>457</td><td>350</td><td>674</td></tr> <tr><td>680</td><td>347</td><td>510</td><td>466</td><td>340</td><td>693</td></tr> <tr><td>670</td><td>352</td><td>500</td><td>475</td><td>330</td><td>713</td></tr> <tr><td>660</td><td>358</td><td>490</td><td>485</td><td>320</td><td>735</td></tr> <tr><td>650</td><td>363</td><td>480</td><td>495</td><td>310</td><td>757</td></tr> <tr><td>640</td><td>369</td><td>470</td><td>505</td><td>307</td><td>764</td></tr> <tr><td>630</td><td>375</td><td>460</td><td>516</td><td></td><td></td></tr> <tr><td>620</td><td>382</td><td>450</td><td>527</td><td></td><td></td></tr> <tr><td>610</td><td>388</td><td>440</td><td>539</td><td></td><td></td></tr> </tbody> </table> <p>[Flat] machined Size Please refer to the table on the right and confirm with salesman</p>	W	T max	W	T max	W	T max	764	307	600	395	430	552	760	309	590	402	420	565	750	313	580	409	410	578	740	318	570	416	400	592	730	322	560	424	390	607	720	327	550	431	380	623	710	332	540	439	370	639	700	337	530	448	360	656	690	342	520	457	350	674	680	347	510	466	340	693	670	352	500	475	330	713	660	358	490	485	320	735	650	363	480	495	310	757	640	369	470	505	307	764	630	375	460	516			620	382	450	527			610	388	440	539		
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(4) Plastic Mold and Finished Product	(5)
	

(6)	(7)
	

3. Physical Properties :

(8) Temperature (°C)	25	100	200	300	400	500
Density (g/cm ³)	7.82	7.81	7.80	7.79	7.79	7.79
Thermal conductivity (W/mK)	40.5	41.0	43.7	59.3	61.3	39.4
Thermal expansion between 25.4°C & ...°C (10 ⁻⁶ /K)	-	11.4	12.4	13.0	13.8	14.0

4. Mechanical Properties :

(9) Tensile Properties	(10) Compressive yield Strength R _{c0.2}
<p>Sample size: According to ASTM A370</p> <p>Sampling location: Surface</p>	<p>Sample size: dia. 10mm, height 10mm</p>

(11) Impact Toughness
<p>Sample size: 10x10x55mm , Charpy V Sampling location: Center</p>

(12) Hardness homogeneity

GPA1

Surface :381HBW
(41HRC)

¼ Width:371HBW
(40HRC)

Core:361HBW
(38.9HRC)

Size: 307 X 764 mm

Brand G

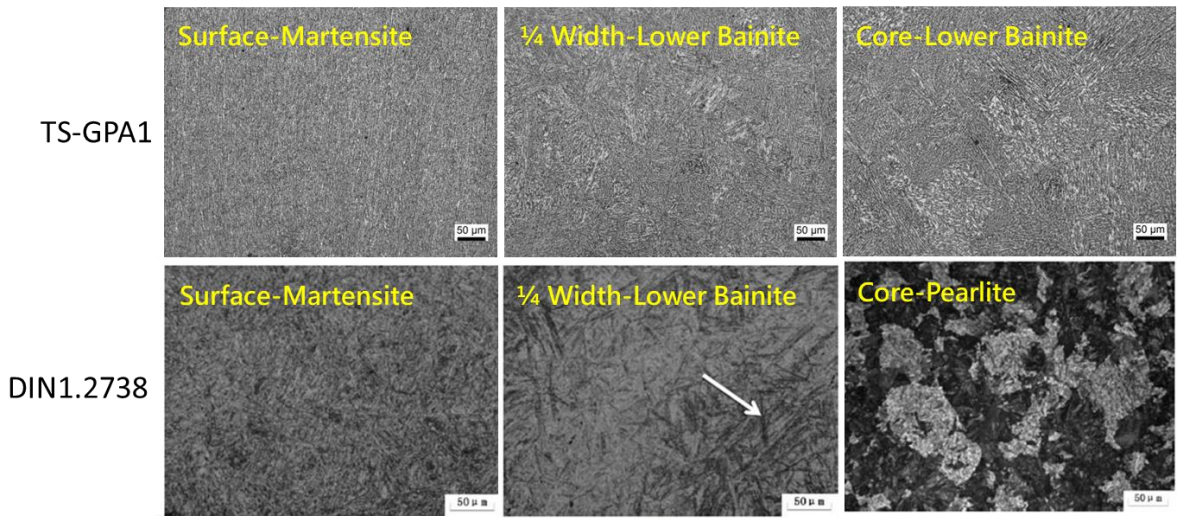
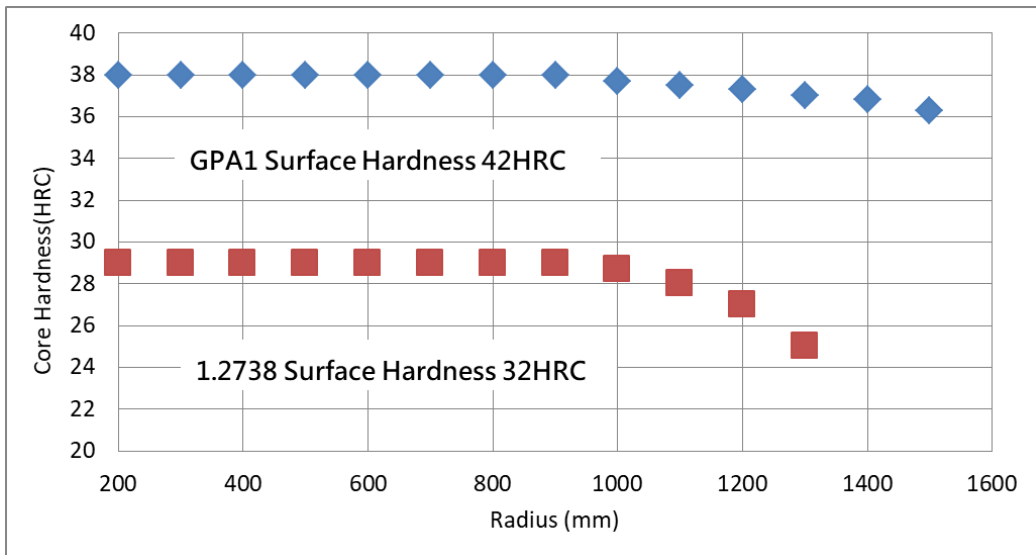
Surface :358HBW
(38.6HRC)

¼ Width:356HBW
(38.3HRC)

Core:343HBW
(36.9HRC)

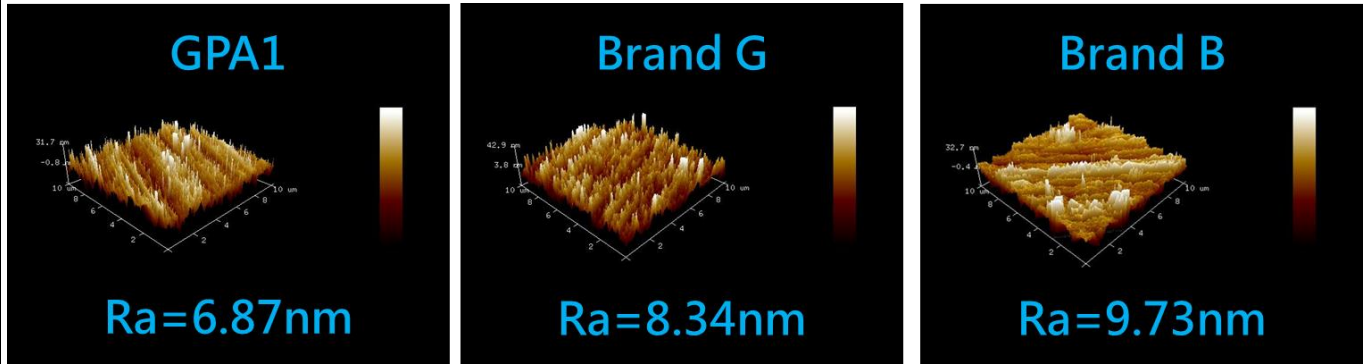
Size: 560 X 1100 mm

(13) Hardenability and microstructure



GPA1 add Mo and V, got higher hardenability than traditional DIN 1.2738, Maintaining core hardness and structural homogeneity as block size increases ◦

(14) Surface roughness –better than other brands



measure by AFM

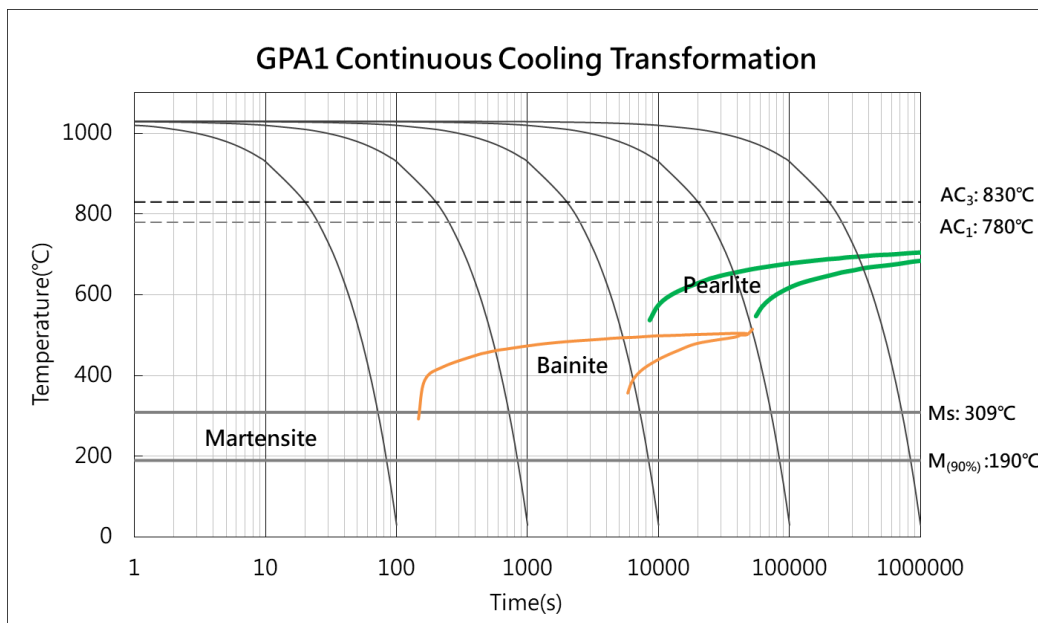
polishing step: paper #80—#100—#400—#1200—DP 3µm

5. Heat treatment :

(15) Process	Temperature (°C)	Holding time	Remarks
annealing	710-740	25mm/hr	Furnace cooling 10-20°C/hr
Austenizing	850-880	25mm/30 min	Oil or polymer cooling
Tempering	According to tempering diagram	25mm/hr	Air cooling
Stress Relieving	500-530	25mm/30 min	At least lower than tempering temperature 30°C

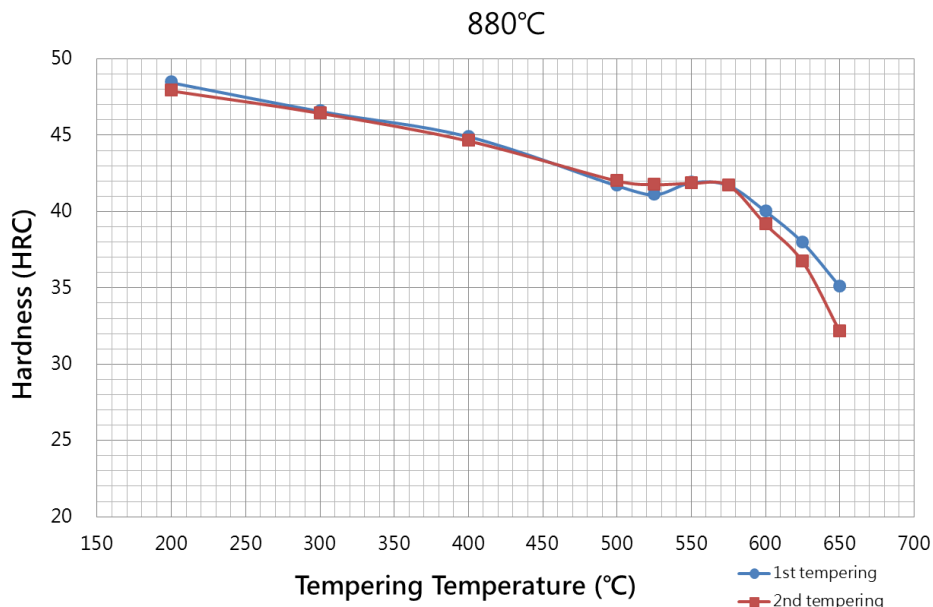
(16) continuous cooling transformation curves of GPA1

Austenitizing temperature : 880°C

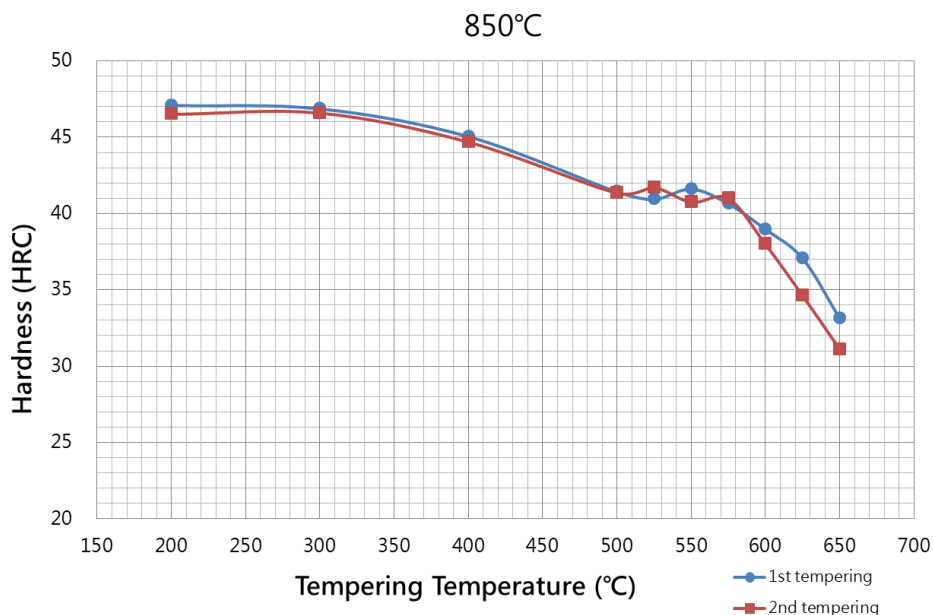


(17) Tempering Chart of GPA1

Austenitizing temperature : 850/880°C (30 minutes)



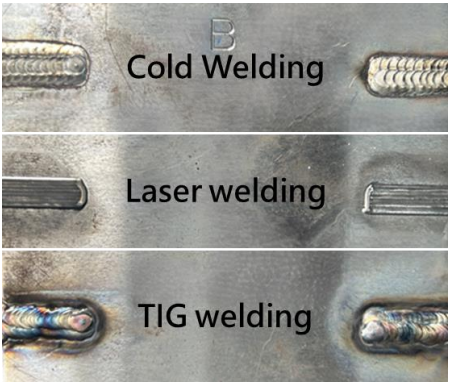
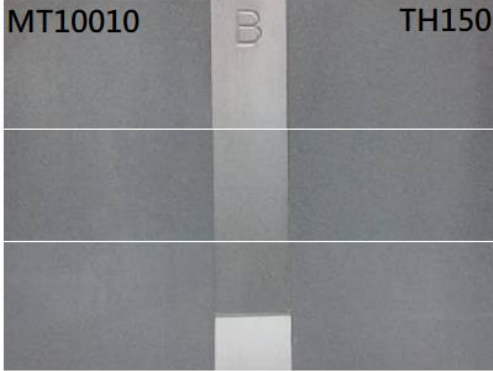
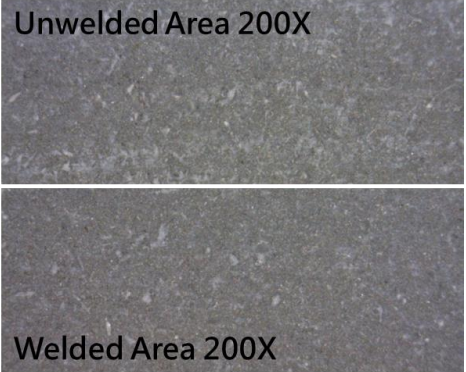
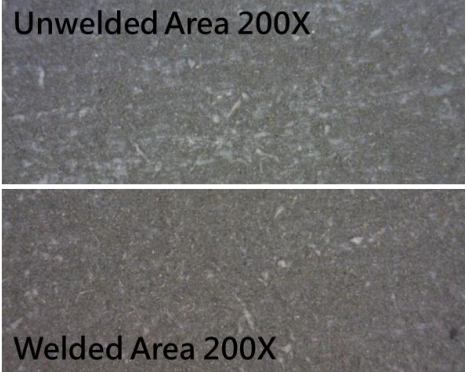
	200	300	400	500	525	550	575	600	625	650
1 st tempering	48.4	46.6	44.9	41.7	41.1	41.9	41.7	40.0	38.0	35.1
2 nd tempering	47.9	46.4	44.6	42.0	41.8	41.8	41.7	39.2	36.7	32.1



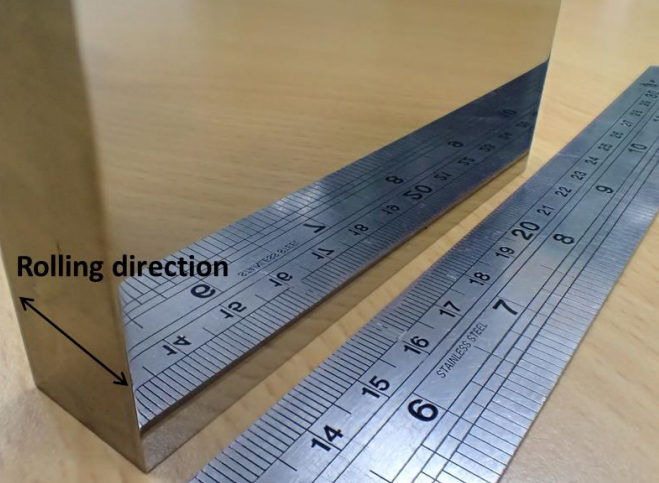
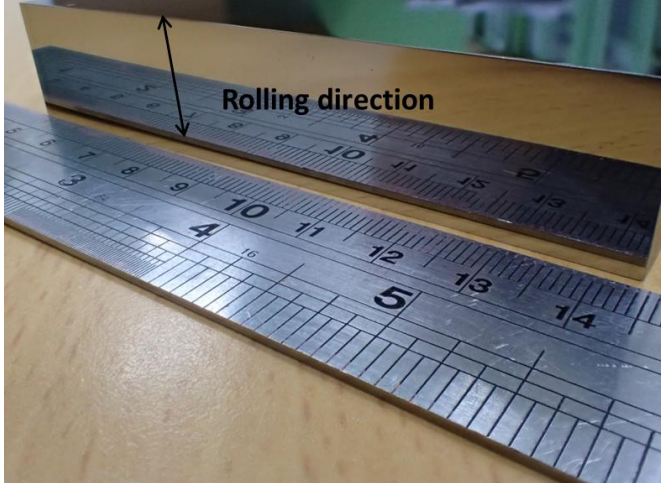
	200	300	400	500	525	550	575	600	625	650
1 st tempering	47.1	46.9	45.0	41.4	40.9	41.6	40.6	39.0	37.1	33.1
2 nd tempering	46.5	46.6	44.7	41.3	41.7	40.7	41.0	38.0	34.6	31.1

Austenitized 30 minutes then oil quenched , tempered two hours then air cooled ◦ Sample size: 25x25x20mm

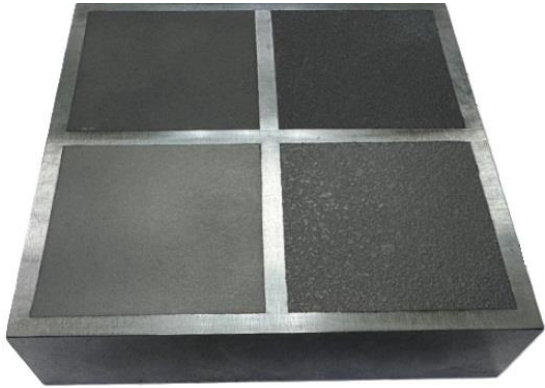
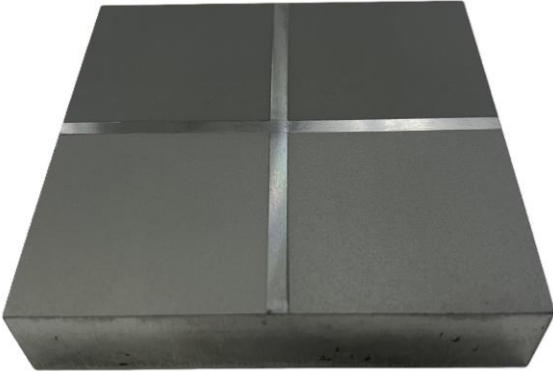
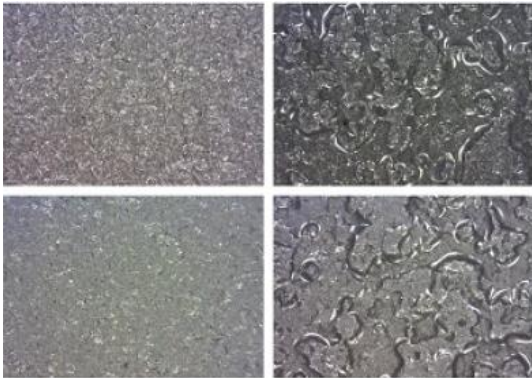
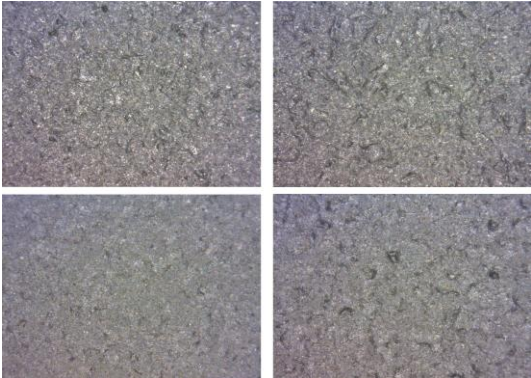
6. Weldability:

(18) After welding	(19) After etching
	
(20) Texture: MT10010 MAG: 200x	(21) Texture: TH150 MAG: 200x
<p>TIG welding:</p> 	<p>TIG welding:</p> 
<p>After welding repair by cold welding, laser welding and TIG welding, grinding, polishing and etching</p>	

7. Polishability :

(22) Polishing surface: cross section	(23) Polishing surface: rolling section
	
<p>polishing with 6000# diamond compound Hardness: 40±2 HRC</p>	
<p>Polishing procedure: stone#320→#400→#600→paper#400→#600→#800→DP 9μm→6μm→3μm→1μm</p>	

8. Photo-etchability :

(24) Tanazawa Hakkosha texture	(25) Mold Tech texture
	
Under 200x microscope :	Under 200x microscope :
	
Sample size: 100x100x20mm Texture type: TH-150 (left), TH-122 (right)	Sample size: 100x100x20mm Texture type: MT11010 (left), MT11030 (right)

9. Machining data : The following cutting data was based on GPA1(360HB)

(26)	Turning with carbide		Turning with HSS	(27)	Milling with carbide	
Lathe Turning				Milling		
Parameter	Rough turning	Fine turning	Fine turning	Parameter	Rough milling	Fine milling
Cutting speed (V _C)				Cutting speed (V _C)		
m/min	100-150	150-200	10-15	m/min	100-140	140-170
Feed (f)				Feed (f _z)		
mm/rev.	0.2-0.4	0.05-0.2	0.05-0.3	mm/tooth	0.2-0.4	0.1-0.2
Depth of cut (a _p)				Depth of cut (a _p)		
mm	2-4	0.5-2	0.5-2.5	mm	2-4	≤ 2
Carbide designation				Carbide designation		
ISO	P20-P30	P10		ISO	P20-P40	P10-P20
Remark	Coated carbide	Coated carbide		Remark	Coated carbide	Coated carbide or cermet

(28)	Type of drilling			(29)	Type of end milling		
Drilling				End Milling			
Parameter	Indexable Insert (Carbide)	Solid Carbide	Carbide Tip ^(*)	Parameter	Indexable Insert (Carbide)	Solid carbide	H.S.S.
Cutting speed (V _c)				Cutting speed (V _c)			
m/min	150-170	120-150	60-90	m/min	60-100	60-100	25-30
Feed (f)				Feed (f _z) (*)			
mm/rev.	0.03-0.12	0.05-0.20	0.10-0.20	mm/tooth	0.006-0.20	0.06-0.20	0.02-0.35
Drill diameter				Carbide designation			
mm	20-40	5-20	10-20	ISO	K10, P40	P20-P30	-
Remark	(*) Drill with internal cooling channels or brazed tip.			Remark	(*)Feed: Depending on radial depth of cut and cutter diameter.		

(30)	High speed steel twist drills(*)				(31)	Grinding : Wheel recommendation
Drill diameter					(a) Face grinding (Straight wheel)	A46HV
mm	≤5	5-10	10-15	15-20		
Cutting speed (V _c)					(b) Face grinding (Segmental wheel)	A24GV
m/min	18-20	18-20	18-20	18-20		
Feed (f)					(c) Cylindrical grinding	A60KV
mm/rev.	0.05-0.15	0.15-0.25	0.25-0.30	0.30-0.35		
Remark					(d) Internal grinding	A60IV
					(e) Profile grinding	A120JV