

metal injection molding

# Precision Made Products

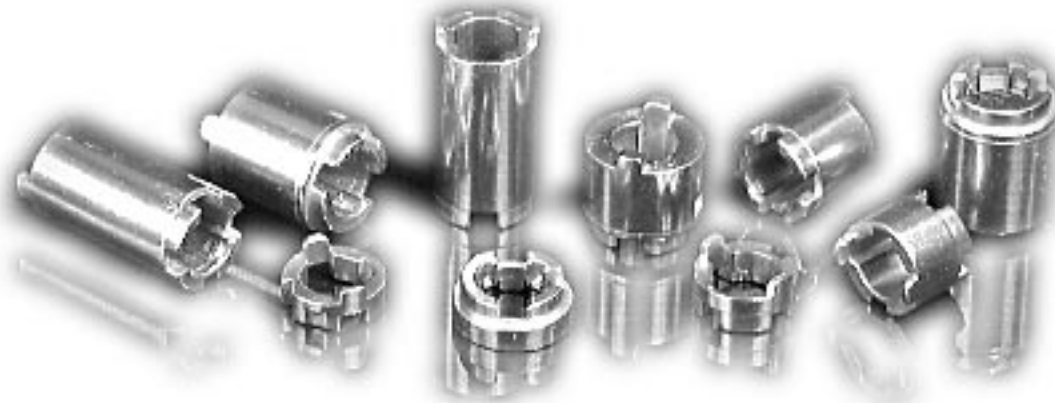
Precision Made Products, LLC  
1126 Industrial Parkway North  
Brunswick, Ohio 44212

PHONE: 330/ 220-5800

FAX: 330/ 220-4440

EMAIL: [info@pmp-tech.com](mailto:info@pmp-tech.com)

WEB: [www.pmp-tech.com](http://www.pmp-tech.com)



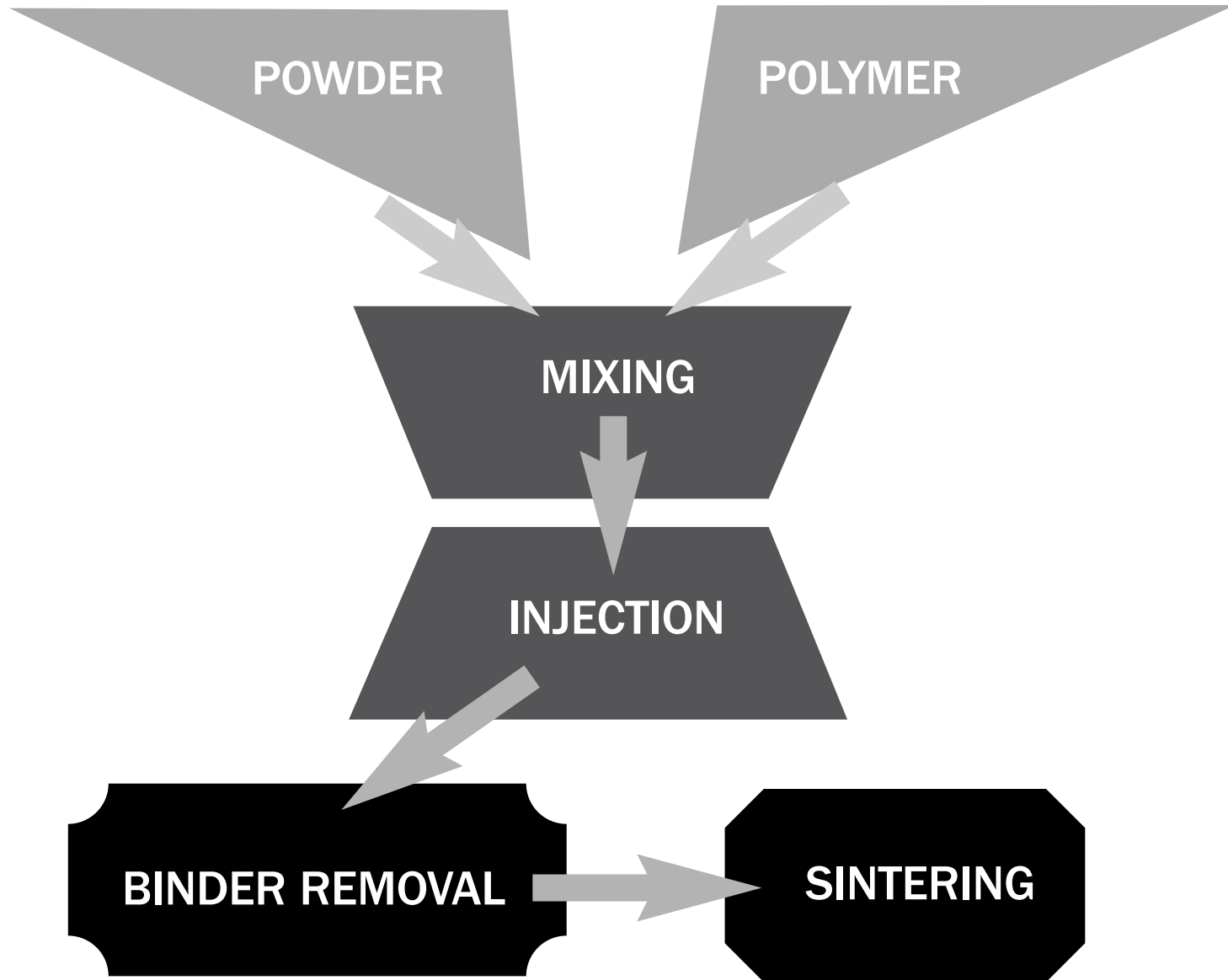
## MIM – METAL INJECTION MOLDING

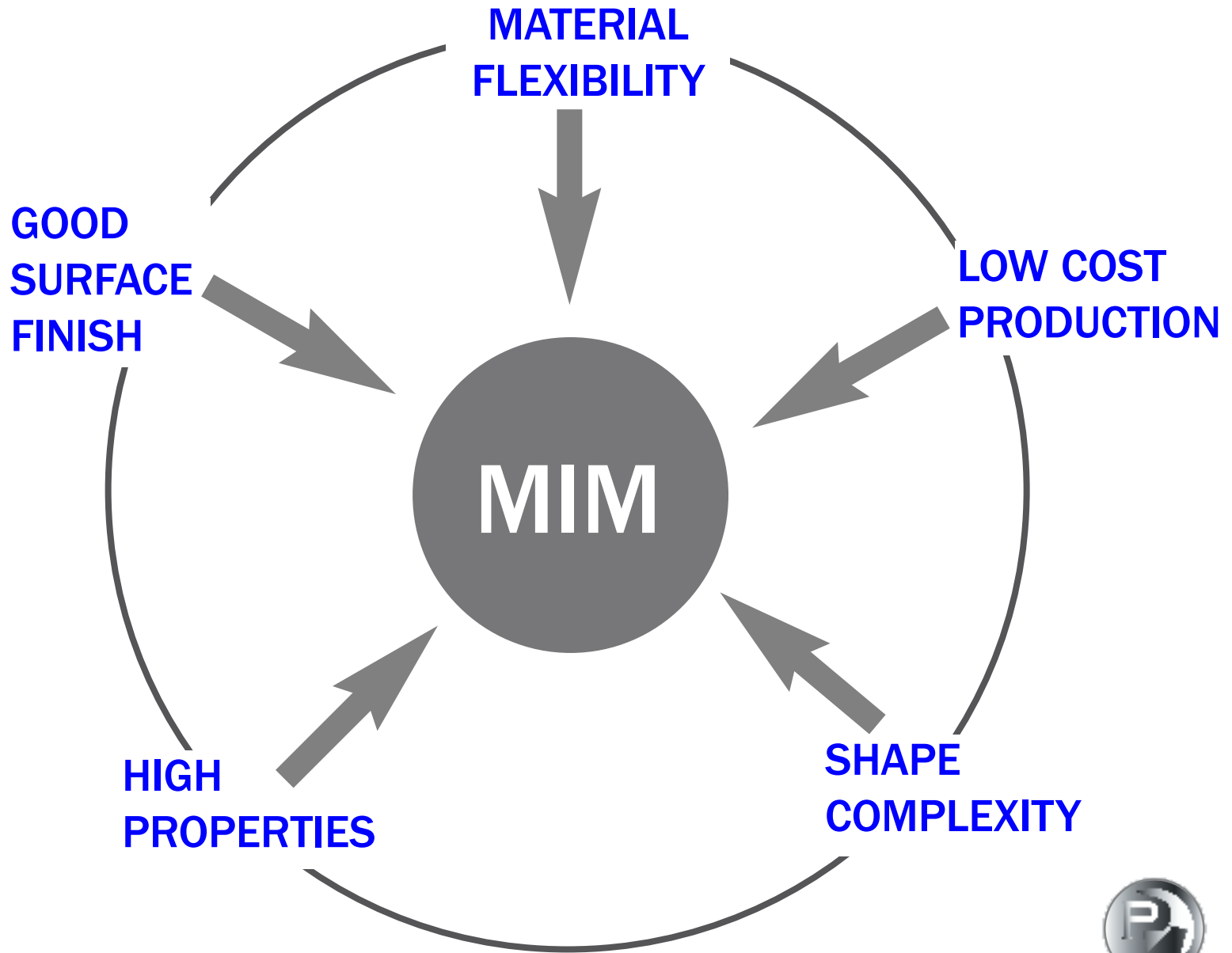
### MIM is a

multi-staged manufacturing technique  
for producing complex shaped  
metal parts  
in medium to large quantities  
in consistent qualities  
in a cost efficient way

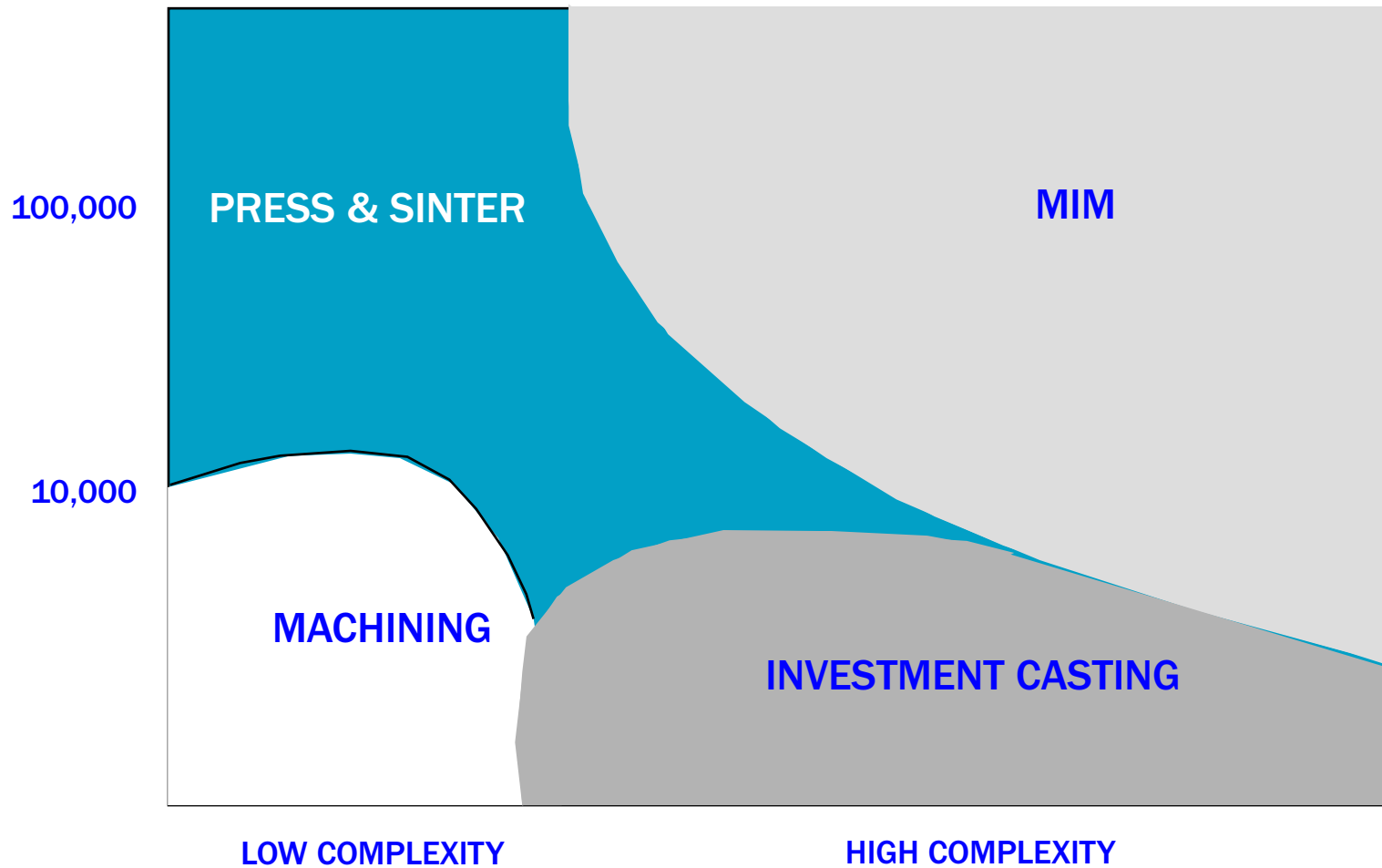


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## WHEN IS MIM ADVANTAGEOUS?



## LOW COST PRODUCTION

Experience shows

25% - 80% price reduction from  
machined parts

50% price reduction from  
investment casting

Precision tolerances significantly  
reduce machining costs

Consolidation of parts leads to further  
cost reduction



## DESIGN CHARACTERISTICS for MIM

Dimensions		Minimum
Internal Bore Diameter		0.2 mm
Radius		0.1 mm
Pitch of Thread		1 mm
Wall thickness		0.1 mm
Wall Thickness $d$		Ratio $L(\text{length})/d$
$0.1 \text{ mm} < d < 0.2 \text{ mm}$		$L/d < 10$
$0.2 \text{ mm} < d < 1 \text{ mm}$		$10, L/d < 15$
$1 \text{ mm} < d < 3 \text{ mm}$		$15 < L/d < 30$
$d > 3 \text{ mm}$		$25 < L/d < 30$
Tolerances		Typical
Relative of dimension		$\pm 0.5\%$
Absolute tolerance		$\pm 0.02 \text{ mm}$
Density		Typical
Relative density		98%
Surface Roughness		Typical
Surface Roughness $R_t$		2-4 $\mu\text{m}$
Surface Roughness $R_a$		0.4-0.8 $\mu\text{m}$
		Limit
		1 $\mu\text{m}$
		0.2 $\mu\text{m}$



## MIM MATERIALS

### STAINLESS STEEL

17-4 PH

304

440C

316

420

321

347

### CARBON AND LOW ALLOYED STEEL

Fe<sub>2</sub>Ni

Fe<sub>8</sub>Ni

4605

4650

M<sub>2</sub>



## MIM MATERIALS

### SUPER ALLOYS

Hastalloy X

Iconel 625

Iconel 718

Hiperco 50-A

### OTHER MATERIALS

Titanium

Tungsten Alloys



## MATERIAL RANGE

Material	Hardness [HRC]	Yield Stress 0,2% ≥ psi	Tensile Stress ≥ psi	Elongation after Fracture (L <sub>0</sub> -5d <sub>0</sub> )≥%	Density g/cm <sup>3</sup>
<b>Stainless Steels</b>					
304L	≤215	26,100	66,700 – 98,000	45/35	7.8
316L	≤215	29,000	70,500 – 101,500	40/30	7.85
17-4PH	-	145,000	155,200 – 184,200	10	7.65
410L	≤200	33,400	58,000 – 91,400	20	7.62
<b>Carbon &amp; Low Alloyed Steel</b>					
FeNi2		13,800	13,790	30	7.62
FeNi2		43,500	101,500	19	7.62
FeNi8		17,400	50,700	26	7.66
FeNi8		47,500	108,700	20	7.65
<b>Super Alloys</b>					
738		130,800	155,300 <sub>(at20°C)</sub>	12	7.95
718		158,300	195,000 <sub>(at20°C)</sub>	9	7.92
<b>Titanium</b>					
Ti					
TiAl6V4					
<b>Tungsten Alloys</b>					
WniFe/Cu					
W-Cu					
<i>Other materials available upon request</i>					



# POWDER INJECTION MOLDED TUNGSTEN COPPER COMPOSITES FOR MICRO-ELECTRONICS

## TYPICAL PHYSICAL MECHANICAL PROPERTIES

Material Composition		Density (g/cc)	CTE ( $10^{-6}/K$ )	Thermal Conductivity (W/m-K @ 25 °C)
W %	Cu %			
90	10	17.00	6.60	175
85	15	16.40	7.25	188
80	20	15.70	8.10	197

### Applications

- Heat Spreaders and sinks
- Microwave carriers
- Hermetic packaging bases and housings
- Ceramic substrate carriers

*Other materials available upon request*



**Smithers Quality Assessments, Inc.**

CERTIFICATE OF APPROVAL

Exists to Certify that the Quality Management System of:

**PRECISION MADE PRODUCTS, LLC**  
1126 Industrial Parkway, North  
Brunswick, Ohio

has been assessed and approved by Smithers Quality Assessments, Inc. to the following quality management system standards and requirements:

**ISO 9002, 1994/QS 9000, 1998**

The Quality Management System is applicable for  
injection molding and services related to metal injection molding.

Approval  
Certificate Number Q2-033-1

Original Approval: January 13, 2003

Current Certification: January 13, 2003

Certifying Engineer: January 13, 2003



Smithers Quality Assessments, Inc.  
Quality Management Systems  
11000 West 120th St.

*[Handwritten Signature]*  
\_\_\_\_\_  
William J. Smith, President

This approval is based on a review of the quality management system of the above named company by Smithers Quality Assessments, Inc. 1994 QS 9000, 1998 QS 9000.



## THE PRECISION MADE PRODUCTS EDGE

- ▶ Own feedstock and processing capabilities
- ▶ Full-fledged proven production line
- ▶ Analytical equipment to support processing and production.
- ▶ Total Dedication to Quality and customer satisfaction both QS 9000 and ISO 9002 certified.



## THE ADDED VALUE IN CHOOSING OUR COMPANY

- Partnership from early stages of design and product development
- Selection of proper material
- Quick turnaround
  - On site feedstock compounding
  - Broad range of alloys including super alloys, Ti and W-Cu
  - Close partnership with mold maker with short delivery time
- State-of-the-art equipment
- Maintaining better tolerances due to lower linear shrinkage
- Low cost due to requiring less complex/no supporting structure during sintering stage
- Environmentally friendly binder removal



## **MIM OFFERS THE ADVANTAGES OF PLASTIC INJECTION MOLDING TECHNOLOGY IN METAL PARTS:**

- Part complexity similar to plastic components can now be offered in metals
- Design flexibility can lead to part consolidation
- Wide range of powder metals are available for MIM
- Low material waste
- Structural integrity of MIM components
- Cost effectiveness



## MATERIAL RANGE

Material	Hardness [HRC]	Yield Stress 0,2% ≥lb/in <sup>2</sup>	Tensile Stress ≥lb/in <sup>2</sup>	Elongation after Fracture (L <sub>0</sub> -5d <sub>0</sub> )≥%	Density lb/in <sup>3</sup>
<b>Stainless Steels</b>					
304L	≤215	26,100	66,700 - 98,000	45/35	0.282
316L	≤215	29,000	70,500 - 101,500	40/30	0.284
17-4PH	-	145,000	155,200 - 184,200	10	0.276
410L	≤200	33,400	58,000 - 91,400	20	0.275
<b>Carbon &amp; Low Alloyed Steel</b>					
FeNi2		13,800	13,790	30	0.275
FeNi2		43,500	101,500	19	0.275
FeNi8		17,400	50,700	26	0.277
FeNi8		47,500	108,700	20	0.276
<b>Super Alloys</b>					
738		130,800	155,300 <sub>(at20°C)</sub>	12	0.287
718		158,300	195,000 <sub>(at20°C)</sub>	9	0.286
<b>Titanium</b>					
Ti					
TiAl6V4					
<b>Tungsten Alloys</b>					
WniFe/Cu					
W-Cu					
<i>Other materials available upon request</i>					



## MATERIAL RANGE

Material	Hardness [HRC]	Yeild Stress 0,2% ≥N/mm <sup>2</sup>	Tensile Stress ≥N/mm <sup>2</sup>	Elongation after Fracture (L <sub>0</sub> -5d <sub>0</sub> )≥%	Density gm/cm <sup>3</sup>
<b>Stainless Steels</b>					
304L	≤215	180	460-680	45/35	7,8
316L	≤215	200	500-700	40/30	7,85
17-4PH	-	1000	1070-1270	10	7,65
410L	≤200	230	400-630	20	7,62
<b>Carbon &amp; Low Alloyed Steel</b>					
FeNi2		95	300	30	7,62
FeNi2		300	700	19	7,62
FeNi8		120	350	26	7,66
FeNi8		328	750	20	7,65
<b>Super Alloys</b>					
738		902	1071 <sub>(at20°C)</sub>	12	7,95
718		1050	1342 <sub>(at20°C)</sub>	9	7,92
<b>Titanium</b>					
Ti					
TiAl6V4					
<b>Tungsten Alloys</b>					
WniFe/Cu					
W-Cu					
<i>Other materials available upon request</i>					



## MATERIAL RANGE

Material	Hardness [HRC]	Yield Stress 0,2% ≥ MPa	Tensile Stress ≥ MPa	Elongation after Fracture (L <sub>0</sub> -5d <sub>0</sub> )≥%	Density g/cm <sup>3</sup>
<b>Stainless Steels</b>					
304L	≤215	180	460-675	45/35	7.8
316L	≤215	200	490-700	40/30	7.85
17-4PH	-	1,000	1070-1,300	10	7.65
410L	≤200	230	400-630	20	7.62
<b>Carbon &amp; Low Alloyed Steel</b>					
FeNi2		95	95	30	7.62
FeNi2		300	700	19	7.62
FeNi8		120	350	26	7.66
FeNi8		330	750	20	7.65
<b>Super Alloys</b>					
738		900	1,100 (at20°C)	12	7.95
718		1,100	1,350 (at20°C)	9	7.92
<b>Titanium</b>					
Ti					
TiAl6V4					
<b>Tungsten Alloys</b>					
WniFe/Cu					
W-Cu					
<i>Other materials available upon request</i>					

