



H. Gers:
Aluminium Alloys for High Performance Space Frame Profiles

2012-03-26



Martinrea Honssel: Worldwide Producer of Lightweight Components

Founded	1908								
Turnover (FY 2010/11)	~ 550 Mio. €								
Employees	~ 3.200								
Locations	<table border="0"> <tr> <td>Germany</td> <td>Meschede, Nuttlar, Soest</td> </tr> <tr> <td>Spain</td> <td>Madrid</td> </tr> <tr> <td>Mexico</td> <td>Querétaro</td> </tr> <tr> <td>Brasil</td> <td>Monte Mor</td> </tr> </table>	Germany	Meschede, Nuttlar, Soest	Spain	Madrid	Mexico	Querétaro	Brasil	Monte Mor
Germany	Meschede, Nuttlar, Soest								
Spain	Madrid								
Mexico	Querétaro								
Brasil	Monte Mor								
Technology	High Pressure Die Casting, Permanent Mold Casting, Sand Casting, Rolling, Extrusion, Machining, Assembly								
Products	<table border="0"> <tr> <td>Automotive</td> <td>Components for Motors, Gear boxes, Suspensions, Body-in-White</td> </tr> <tr> <td>Non-Automotive</td> <td></td> </tr> </table>	Automotive	Components for Motors, Gear boxes, Suspensions, Body-in-White	Non-Automotive					
Automotive	Components for Motors, Gear boxes, Suspensions, Body-in-White								
Non-Automotive									
Alloys	Aluminium and Magnesium								



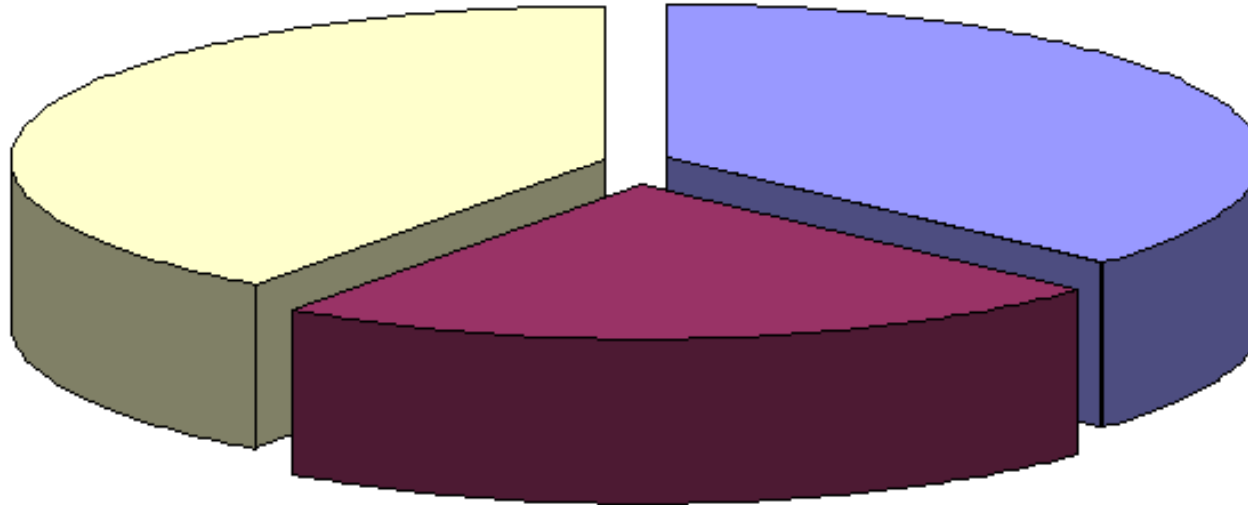
Martinrea International



Soest / Germany



Extrusion Plant Soest



37% Automotive Suspension
23% Automotive Body-in-White
40% Non-Automotive

Sales 2011: 83,7 Mio. Euro
Capacity: 20.000 to/year
Employees: approx. 330



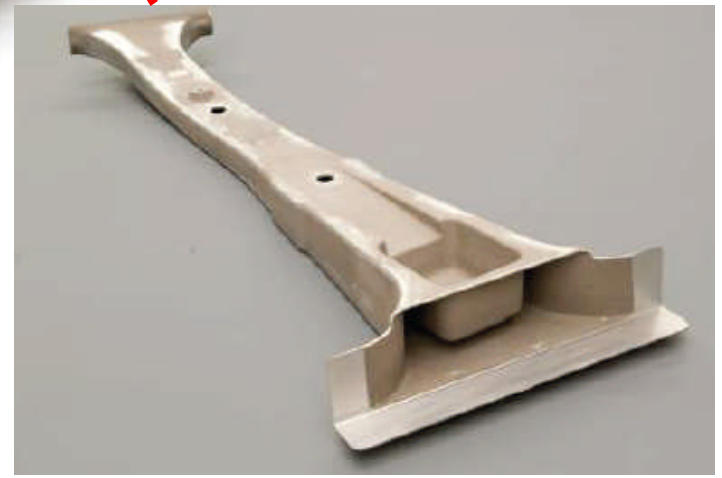
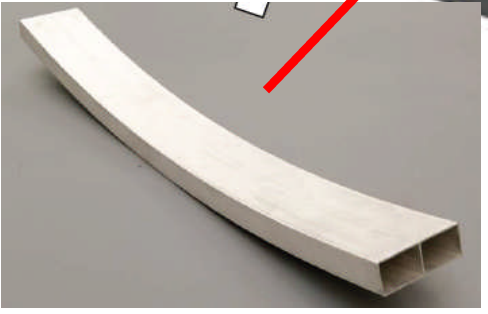
Riveting

Hydroforming
Heatforming

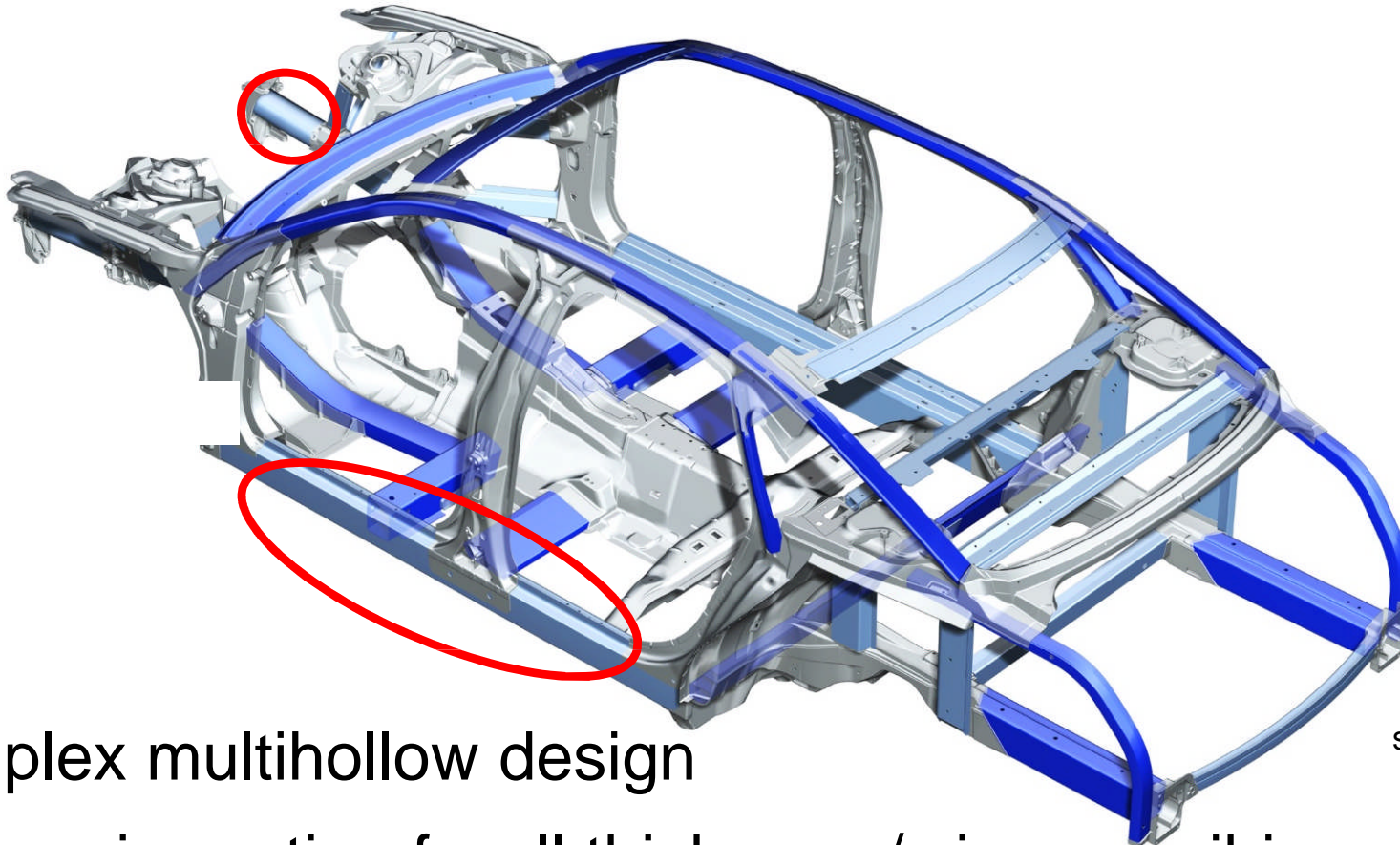


Joining with
Castings

Bending



Side Beam and Front Bumper: Crush-critical part with special requirements:



source: AUDI AG

- complex multihollow design
- decreasing ratio of wall thickness / circumscribing diameter
- increasing mechanical properties, higher ductility

Explanation of different crush behavior:

Audi AG



Crush behavior:

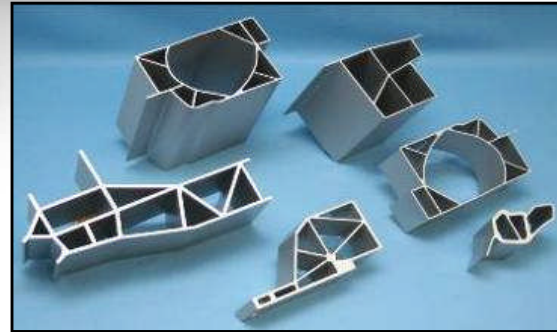
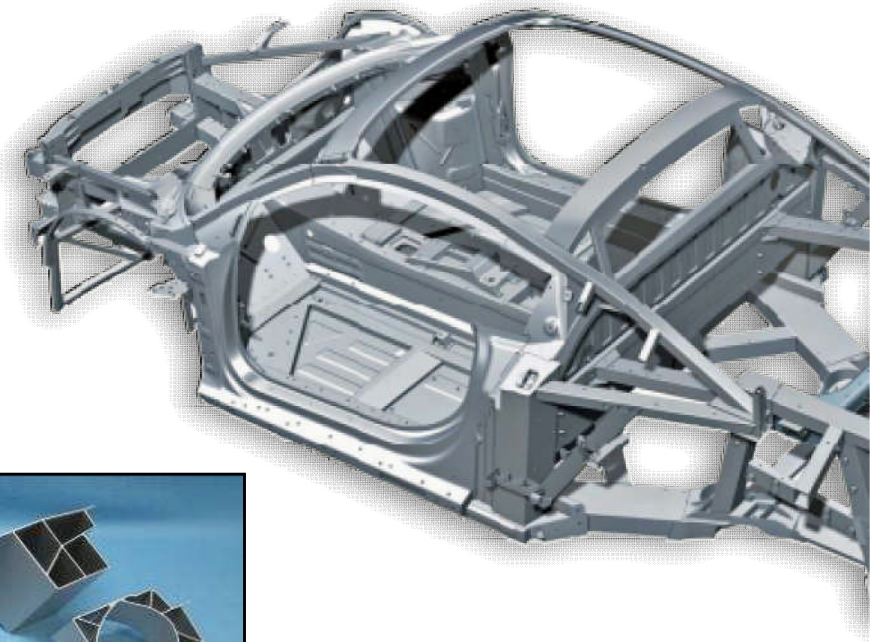
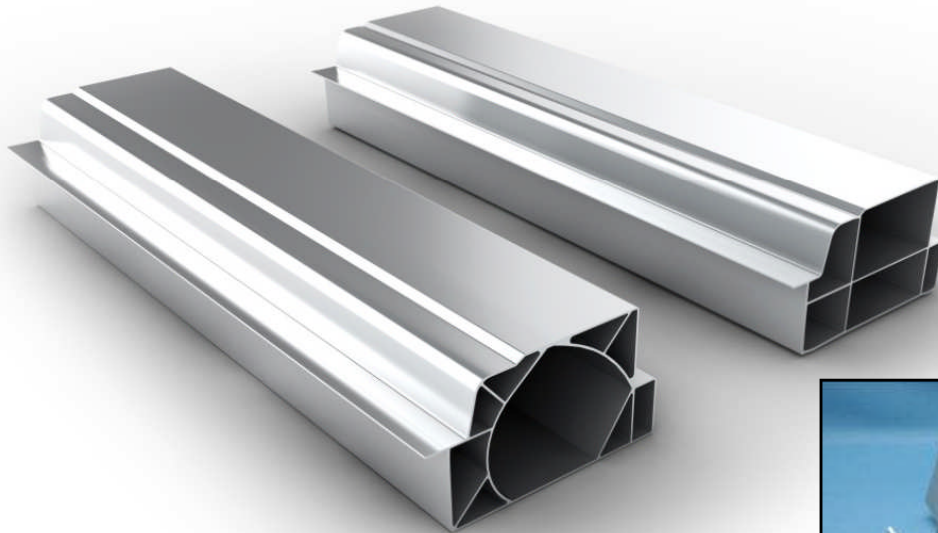
- no folding
- very brittle
- poor general impression



Crush behavior:

- uniform folding
- no cracks
- good general impression

Requirements regarding alloy properties for space frame application



Alloy 6106 T6

Rp0,2 >200 MPa
 Rm >220 MPa
 A >11%

Alloy 6951 T66

Rp0,2 >241 MPa
 Rm >260 MPa
 A >10%

Alloy 6005 T66

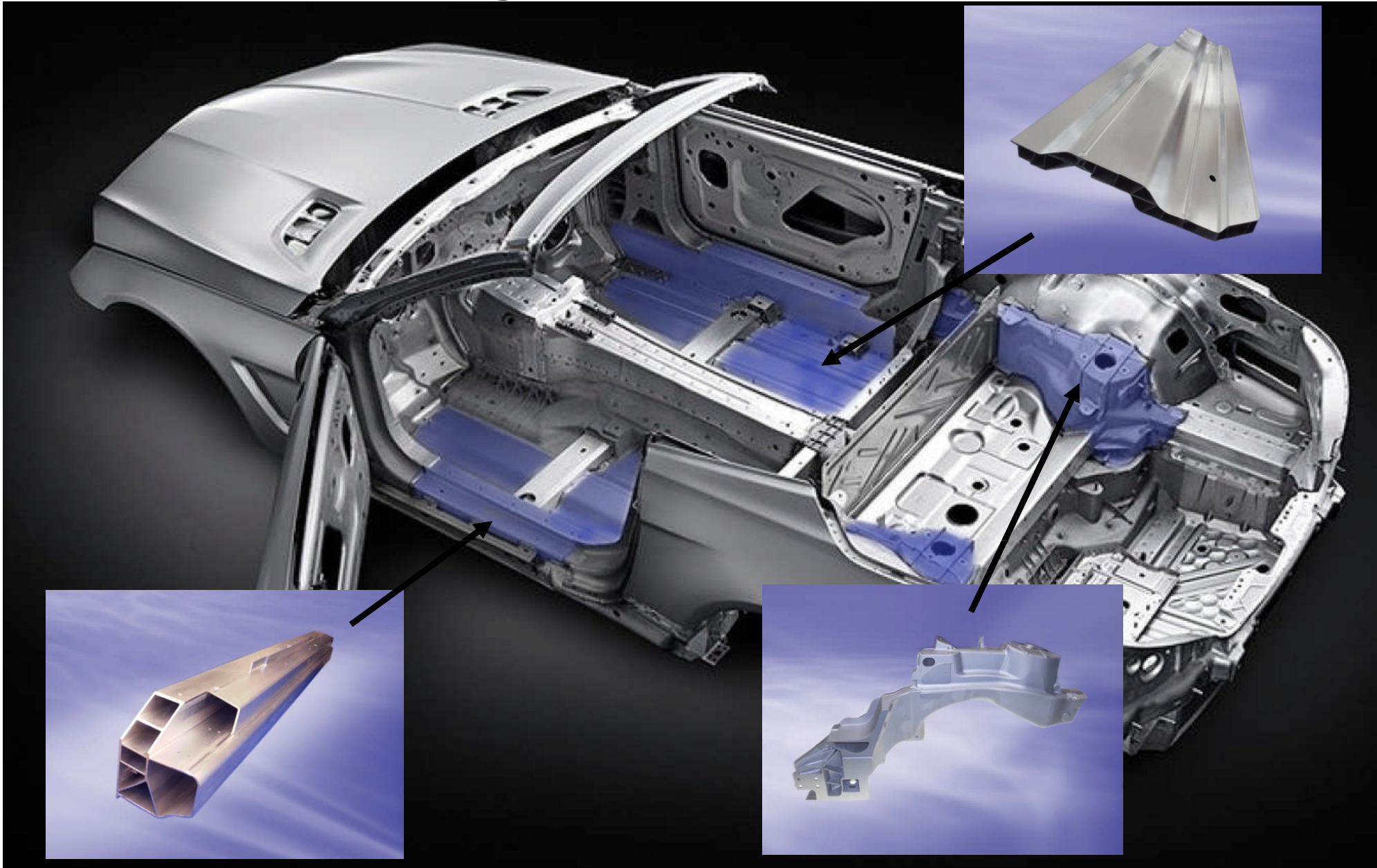
Rp0,2 >280 MPa
 Rm >305 MPa
 A >9%

1992

2004

2009

Products – Body-in-White

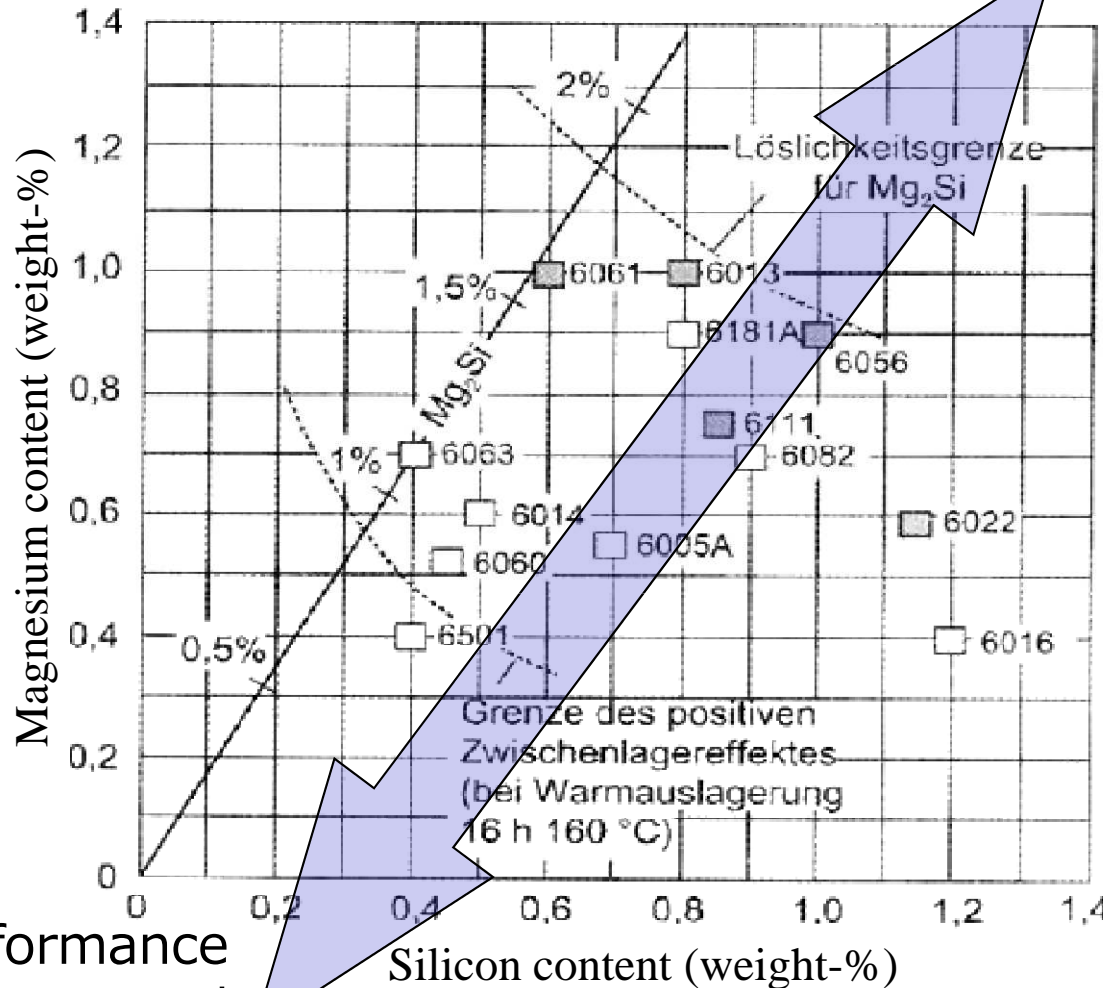




Extrusion Billets

Die Technology

Extrusion Process



higher strength

higher crush performance
higher extrusion speed

Zoller et. al.,
Z. Metallkunde

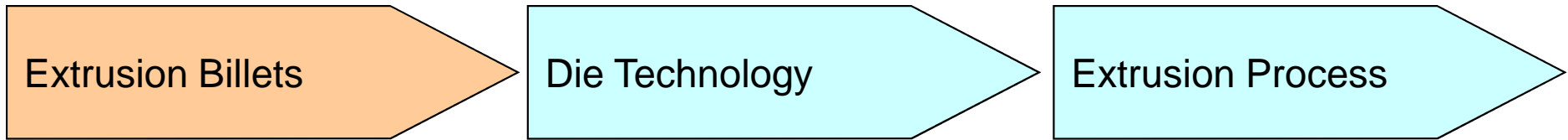
Extrusion Billets

Die Technology

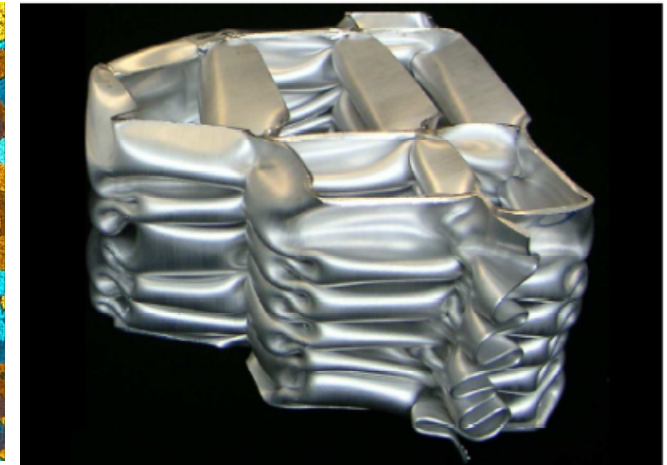
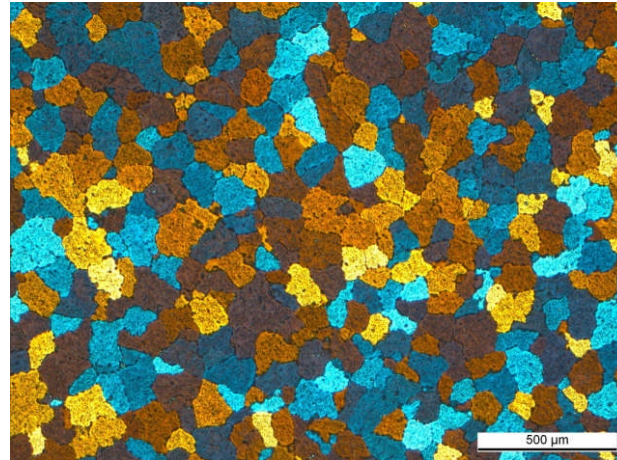
Extrusion Process



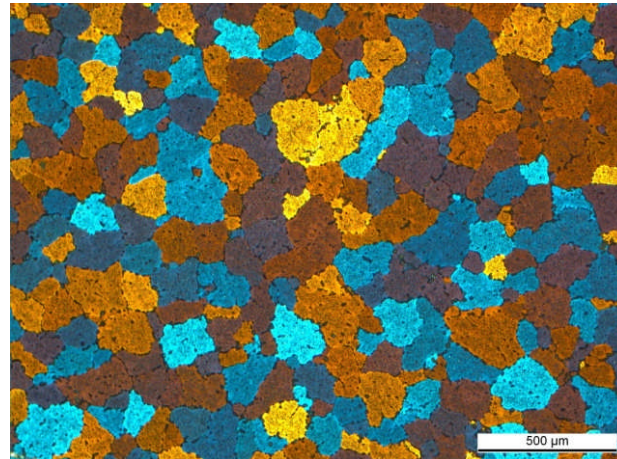
DC-Casting: Process Control

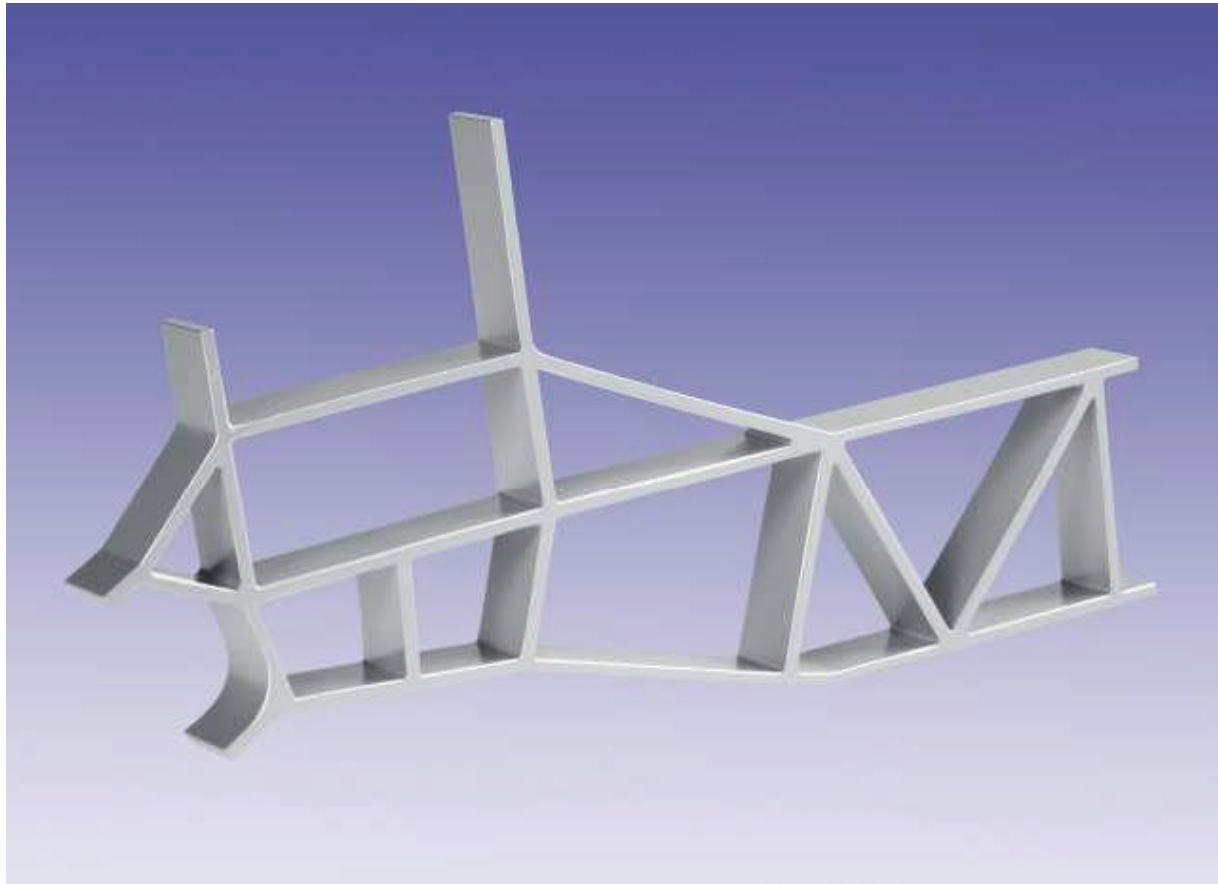
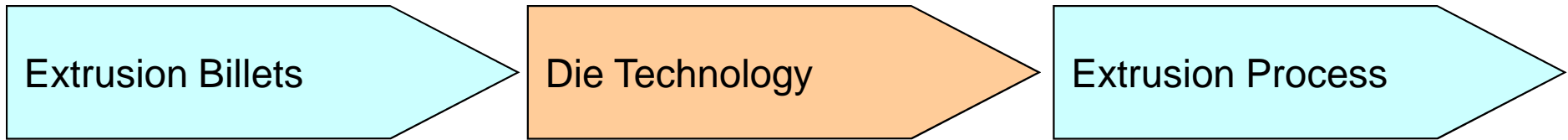


Grain Size ASTM: 3,5
Avg. Diameter ~ 90 μm

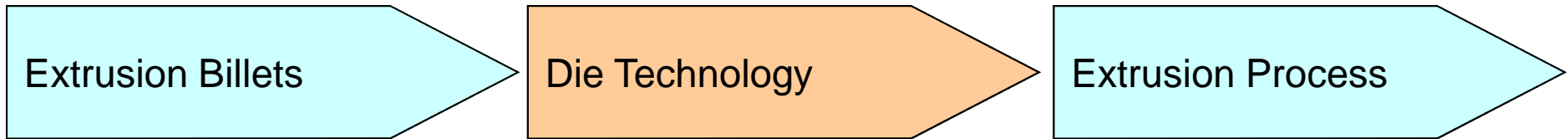


Grain Size ASTM: 2,5
Avg. Diameter ~ 150 μm

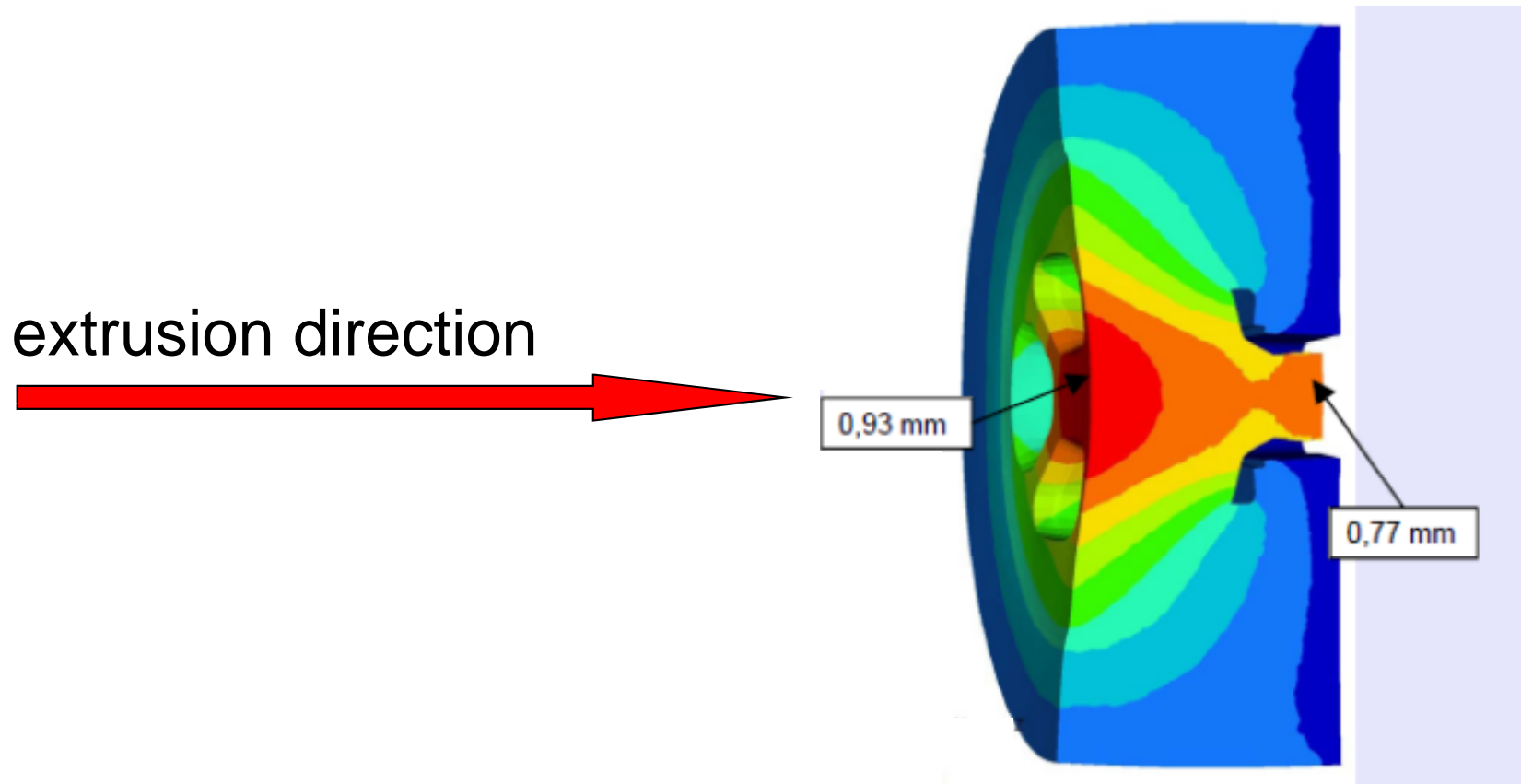


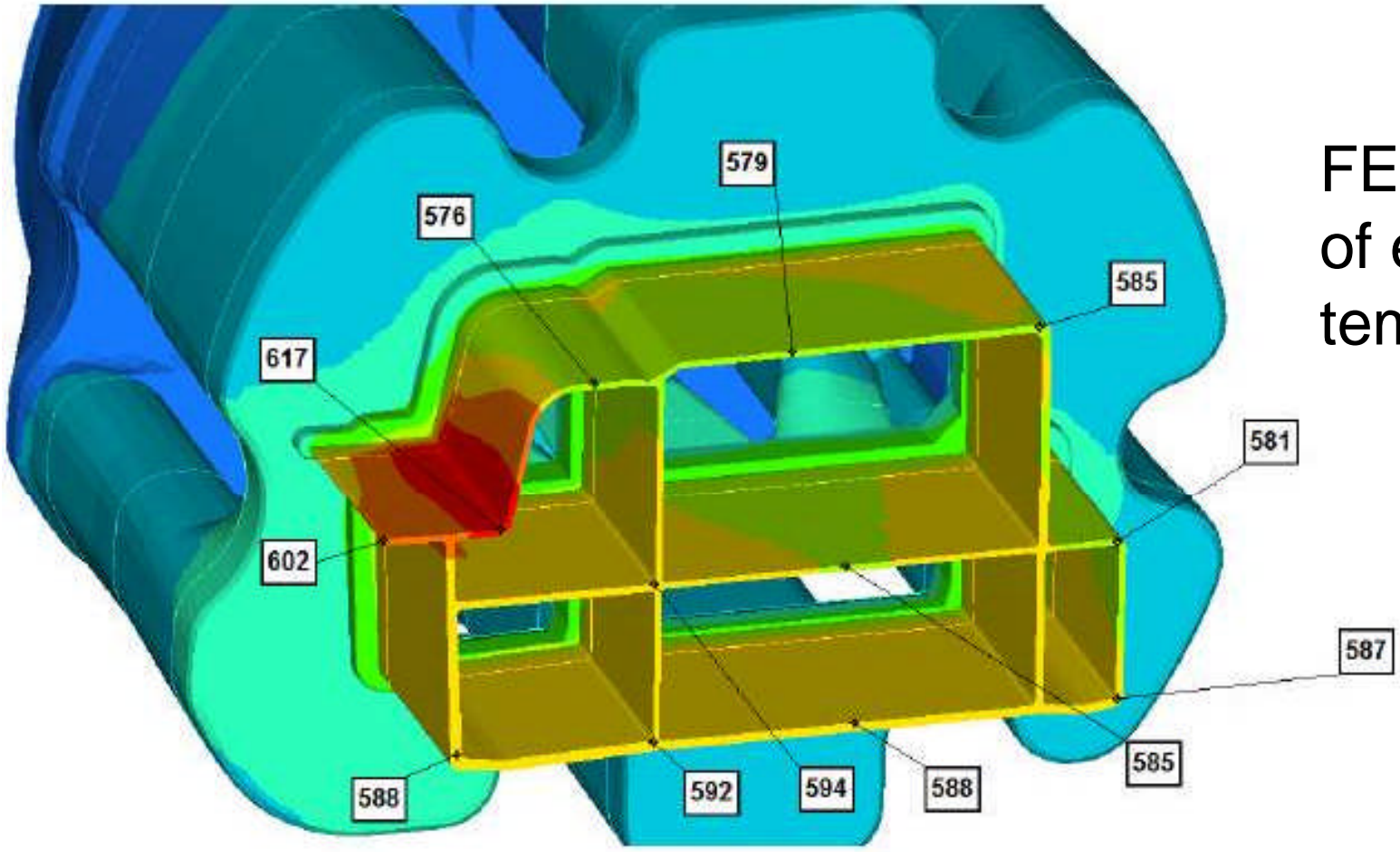


Complex profile structures with high risk of die failure

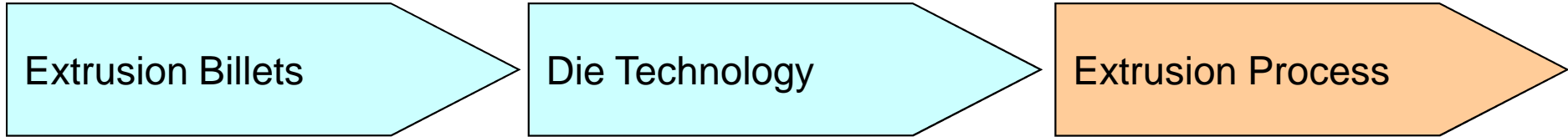


FEM calculation of die deformation





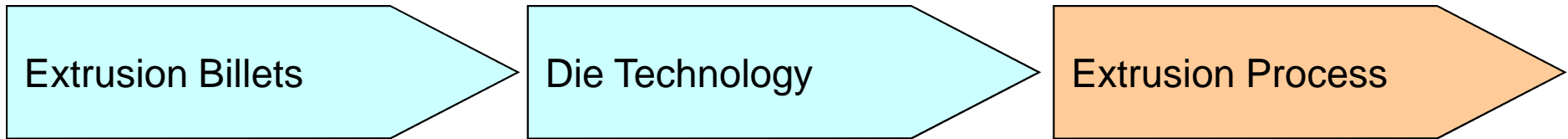
FEM calculation of extrusion temperatures



globulitic precipitations :
good crush performance



plate-like precipitation :
poor crush performance



Result: excellent crush performance

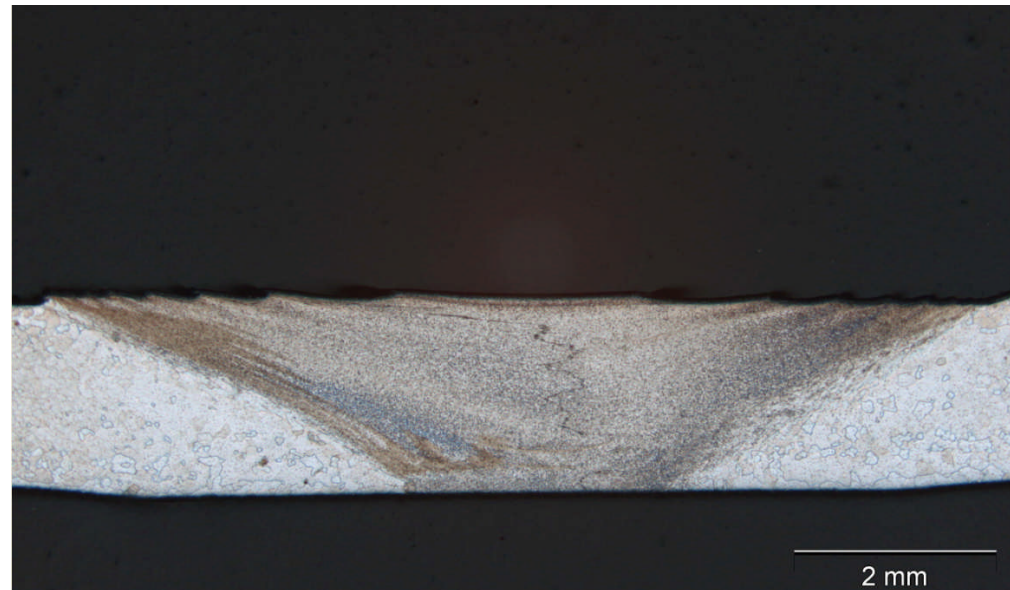
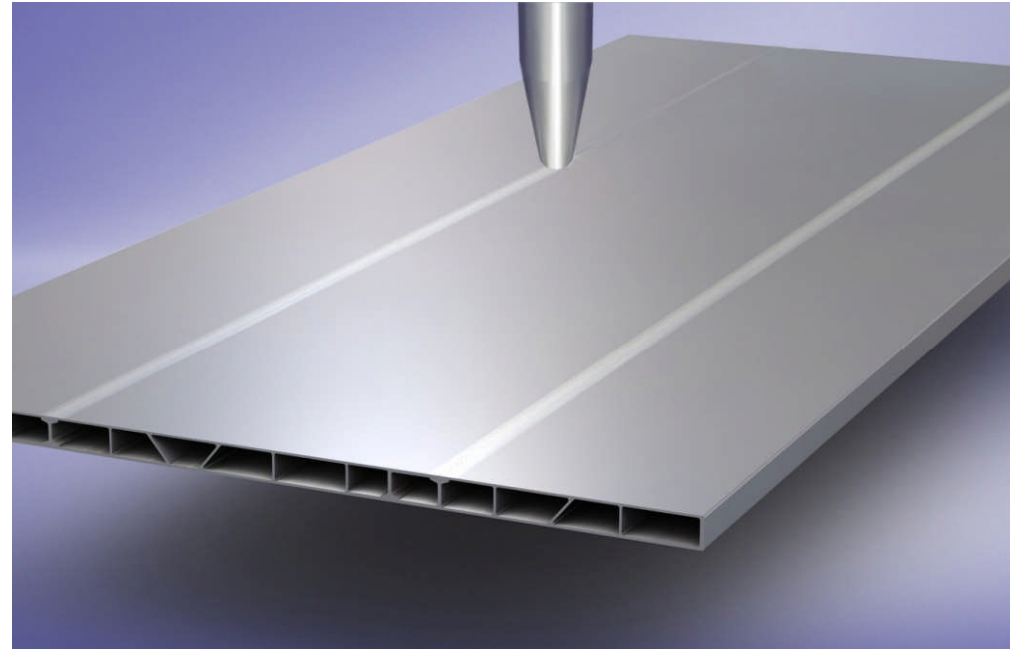
Development: FSW

Advantages

- low heat disposal
- minimum distortion
- large wall thickness
- excellent weld quality
- good mechanical properties
- material combination possible

Disadvantages

- 3D structures difficult to weld





Mechanical Properties

	Base Material longitudinal	Welding Seam longitudinal		Base Material transvers	Welding Seam transvers	
Tensile (MPa)	224	170	-25%	223	172	-23%
Yield (MPa)	185	128	-31%	183	125	-32%
Elong. (%)	14	18		15	10	

Crushtest on FSW-parts



Technical Data of Extrusion Presses

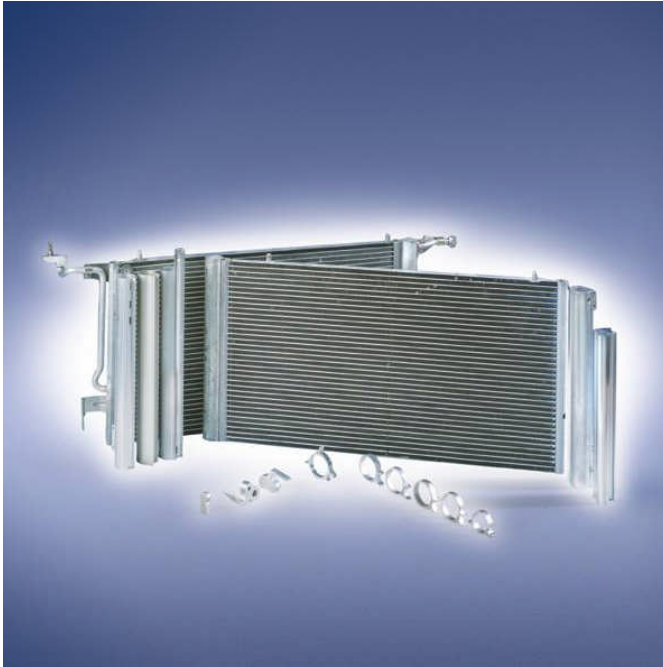


		P22	P44
Extrusion Force	(MN)	22	44
Circumscribing Diameter	(mm)	220	420
Extrusion Length	(m)	51	51,5
max. Weigth	(kg/m)	5	30

Overview Alloys

Alloy	Typical Mechanical Properties			Properties	Applications
	Tensile (MPa)	Yield (MPa)	Elong. (%)		
EN AW 1200	100	50	20	Surface quality	
EN AW 2618	450	360	8	Strength at higher temperatures	Bearing Cap
EN AW 3103	120	50	28	Solderability	Heat Exchanger
EN AW 6060	220	180	12	Good extrudability	Airbag Housings
EN AW 6063	270	220	10	Medium tensile strength alloy	
EN AW 6082	350	300	8	Good cycle strength	Bearing Housing
EN AW 7020	380	320	10	High tensile strength	Rollover Bar
EN AW 6026	350	300	10	Good machining performance	Valve Control Unit
EN AW 6106	260	220	10	Good crush properties	Space Frame Extrusions
EN AW 6951	280	260	10		
EN AW 6005	310	300	8		

Products



Tubes for Heat Exchanger

Alloy: EN AW-3103
(AlMn1)



Bearing Cap for Engines

Alloy: EN AW-2618A
(AlCu2Mg1,5Ni)

Products



Primary Material for Forgings

Alloy: EN AW-6110
(AlMg1SiCu)



Steering Shaft

Alloy: EN AW-6082
(AlSi1MgMn)

Products



Tension Strut Mounting Bracket
6,000 parts/day
EN AW 6060



Bearing Housing
18,000 parts/day
EN AW 6082



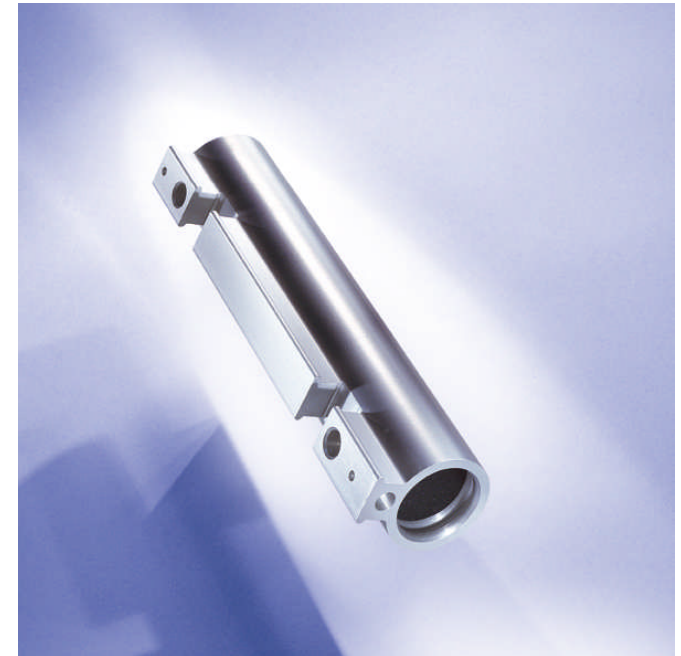
Retaining Clamp for Cockpit
8,500 parts/day
EN AW 6060

Products



Rollover Bar for Cabriolet

Alloy: EN AW-7108
(AlZn5Mg1Zr)



Hydraulic Cylinder for Cabriolet Roof Drives

Alloy: EN AW-6060
(AlMgSi)



Thank you for your attention !