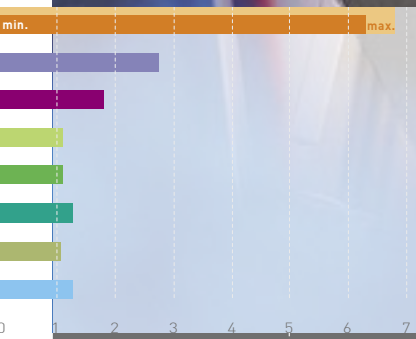

Why Zinc Diecastings?

ZINC

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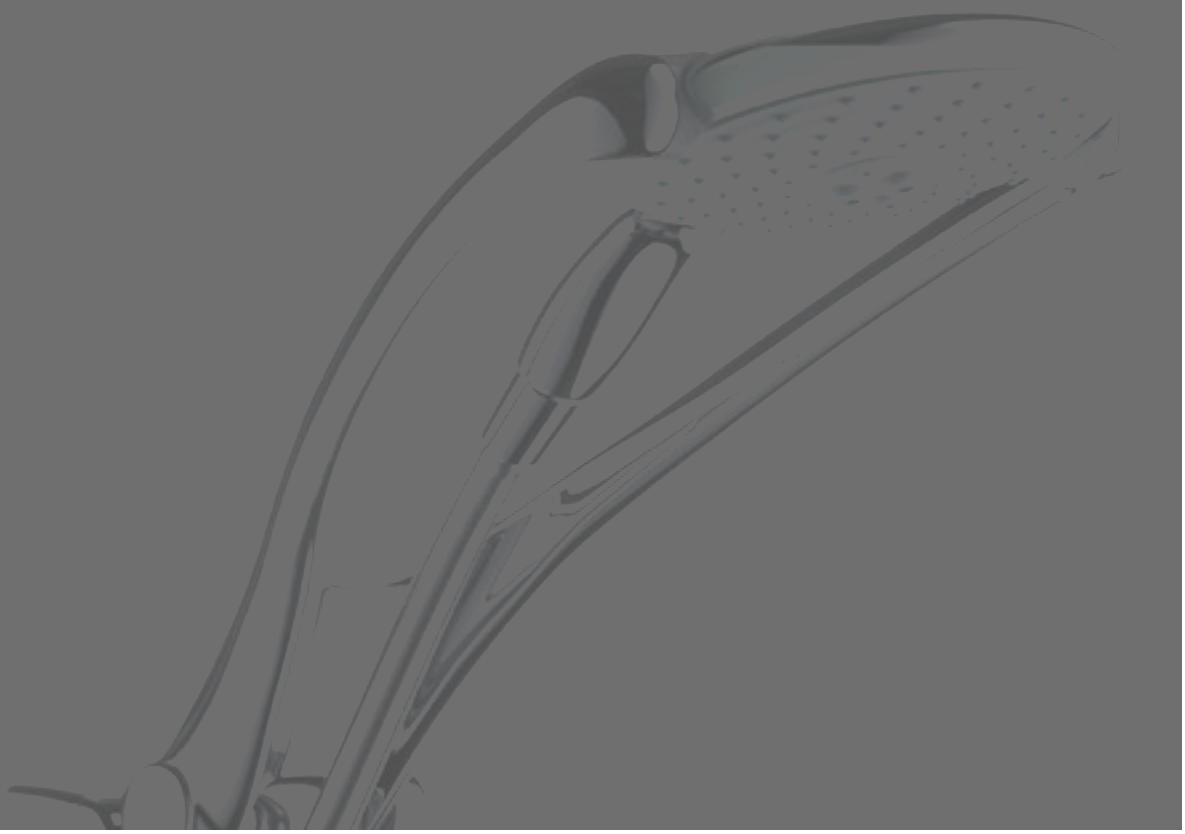


Enhance Your Brand Product and Reputation:
Engineered Zinc Diecastings for optimal Design Freedom and Precision.

The die casting process

The die casting process is a forming process in which molten metal is injected into the cavity of a steel die. The cavity is precision machined, with tight tolerances, into a block of heat resistant tool steel. Coupled with process control and the uniform shrinkage characteristics of zinc alloys, this process results in castings with exact precision. In zinc alloy die casting, the production cycle is the fastest of the metal casting processes due to zinc's relatively low melting/solidification temperature (379-390°C). Zinc die casting is used to produce parts from less than a gram in weight to a kilo or more.

Contents

Environmental Harmony

ZINC IS A MICRONUTRIENT. ALL LIVING ORGANISMS AND PLANTS REQUIRE ZINC TO FUNCTION.

Humans need zinc for a multitude of critical functions. It positively affects the immune system, growth and development, fertility, eyesight, learning and wound healing. In some areas of the world zinc deficiency is a major health problem.

Pollution and greenhouse gasses are minimised with zinc diecasting:

- Negligible emissions to air, land and water.
- Much smaller energy consumption than comparable alternative mass manufacturing processes.
- No environmentally harmful blanket gasses required in processing.
- Any 'scrap' product from processing can be recycled.

Zinc alloys, as defined by international chemical composition standards, comfortably conform to the requirements of the End of Life Vehicle (ELV), Restriction of Hazardous Substances (RoHS) and Waste Electrical and Electronic Equipment (WEEE) legislation.

Zinc diecastings are premium quality low cost products that are highly resilient to many hostile conditions. They display considerable corrosion and wear resistance thus **resulting in very long and reliable service, frequently measured in decades, and saving resources by not needing to be frequently replaced.**

- A recycling infrastructure is actively in place to treat today's zinc processing scraps and tomorrow's end of life cast zinc alloy products. Zinc castings can be marked with the Zinc Logo and the ISO recycling mark as featured in EN 12844 for easy alloy recognition and future recycling.

ISO recycling mark
COURTESY OF AMI FONDERIE

Aesthetic Attraction

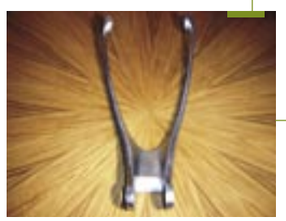
ZINC DIECASTINGS CAN BE SIMPLE, SLEEK AND ELEGANT, AND THEY CAN BE BREATHTAKINGLY SOPHISTICATED IN THEIR GEOMETRIC COMPLEXITY AND FUNCTION.

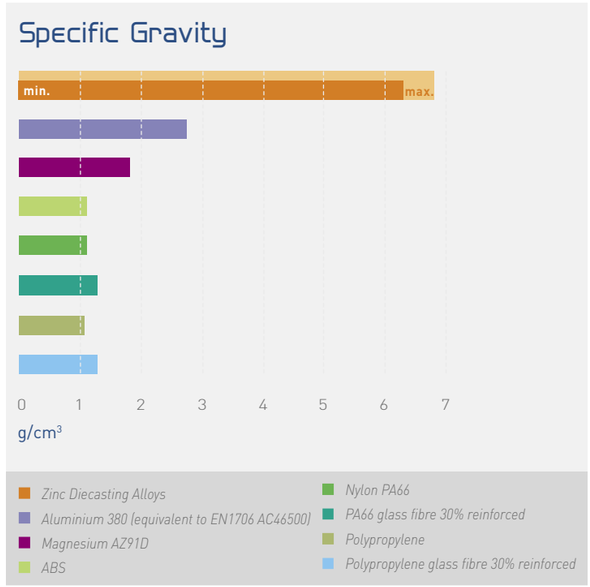
When clever design is combined with the versatility of the zinc diecasting process, it maximises the aesthetic appeal of products. For example:

- Inexpensive bulk vibratory finishing can be used to improve the 'as cast' surface. Exceptionally smooth finishes can be obtained prior to finishing by lightly buffing or chemical polishing.
- Due to the high fluidity of zinc alloys a precisely defined surface texture can be added to part, or all, of the 'as cast' product.
- Other external features such as lettering and logos can be 'cast in'.
- **An unrivalled range and quality of conversion coatings, organic paint and superb electroplated metal finishes (e.g. nickel, satin and bright chrome) can be easily and reliably applied to any selected surfaces of your component.** Excellent substrates help yield excellent finishes.
- Zinc alloy's density and its counter pointing ability to be very thinly cast allow the designer to influence the user's perception of weight, balance, solidity and inertia. For instance, **coolness in hand, a premium quality metallic feel and other perceived sensations are factors valued by many users of zinc diecastings**. On the other hand, 'warm feel' coatings and plastic over-moulding are also tactile options that the designer can utilise.

For maximum impact and success, the designer is advised to consult the diecaster at an early stage to agree on the best way of designing an economical and aesthetically attractive product.

rain dance
COURTESY OF HDO





water tap
COURTESY OF INJEKTA

Strength

USED FOR SEAT BELTS, MOTOR HOUSINGS, LOCK MECHANISMS AND MANY OTHER APPLICATIONS, ZINC DIECASTINGS HAVE A REPUTATION OF SUPERB FUNCTIONALITY AND RELIABILITY BASED UPON THE DIFFERENT TYPES OF STRENGTH THAT THEY EXHIBIT:

- Zinc diecastings' ambient temperature **Yield Strengths** are far more superior than those of Aluminium 380 and Magnesium AZ91D.
- Zinc diecastings' **Ultimate Tensile Strengths (UTS)** can outperform Aluminium 380 and Magnesium AZ91D. Engineering Plastics struggle to deliver equivalent performance of zinc alloy's UTS. Even glass-reinforced Nylon cannot achieve zinc alloy's UTS.

Zinc alloys display a high degree of energy absorbing plasticity when subjected to abusive or destructive levels of loading:

- At fracture, zinc elongation levels can typically range from 4% to 6%, but can be as high as 12% in thicker wall sections. This means that it can be possible to avoid sudden unexpected catastrophic failures by observing the warnings given by a distorting zinc diecasting when over-loaded. In comparison aluminium and magnesium fail more suddenly at around 3% and with no such warning.

The strength of zinc diecastings - in shear, torsion, under bending and in compression - is far superior to aluminium, magnesium and plastics:

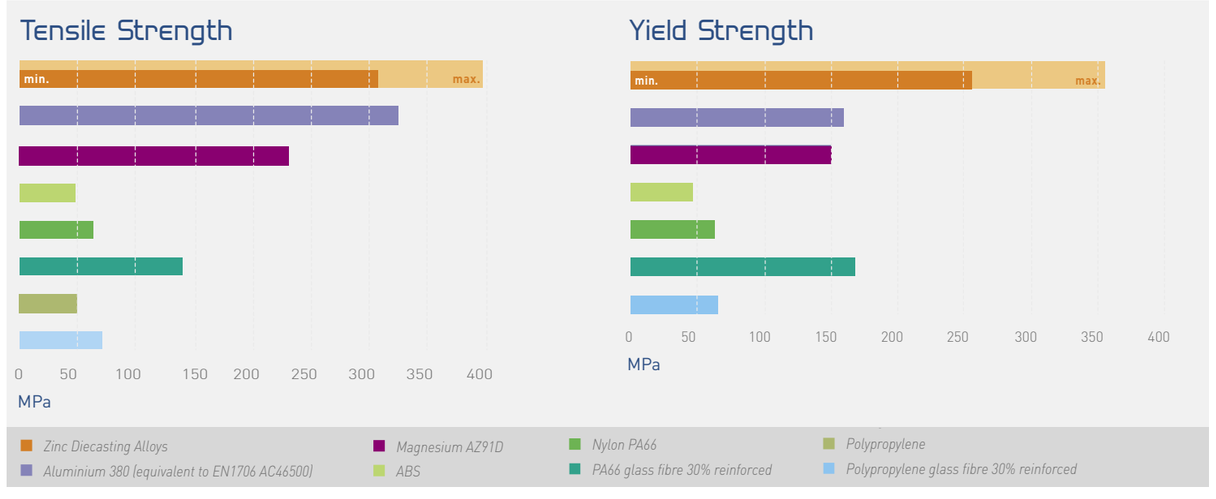
- With a **Young's Modulus** of around 96,000 MPa, zinc diecastings are more rigid than Aluminium 380, size for size, and twice as stiff as Magnesium AZ91D.
- Most plastic products would have to be extremely thick in cross-section to compete in engineering terms, thus adding considerably to the cost.

During the casting process, zinc alloy is exceptionally fluid which allows reduced weight and optimal strength of the thin walled castings. Thus, thin but very strong load bearing elements can be placed exactly where they are needed (e.g. at the extremities of the product) for maximum structural strength and performance.

For applications involving continuous loading at elevated temperatures, such as locks, zinc has superior creep strength to reinforced injection moulded plastics.

stapler
COURTESY OF CAST METALS FEDERATION

locks
COURTESY OF CAST METALS FEDERATION

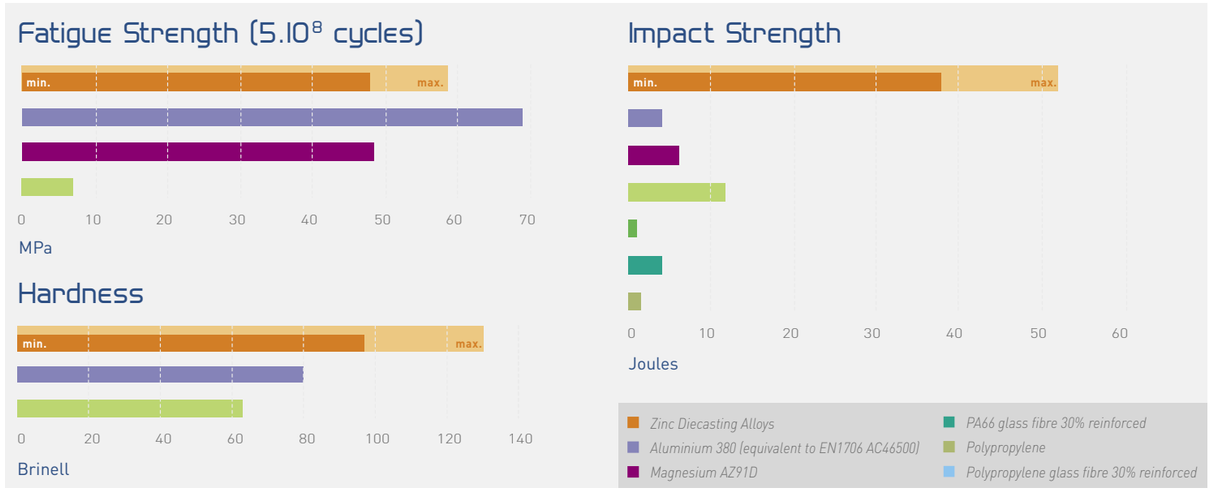


Toughness

PROVEN REPUTATION OF RELIABILITY AND RESISTANCE TO HOSTILE LOADING-ENVIRONMENT CONDITIONS:

- At normal ambient temperatures, zinc diecastings have a much greater **impact resistance** than Aluminium 380 and Magnesium AZ91D, and ABS plastics. At minus 30ºC zinc alloys still remain far better. Even at minus 40ºC zinc at least matches the impact resistance of diecast aluminium.
- Zinc alloys are significantly **harder** than aluminium and magnesium. Alloying additions such as copper, contribute considerably to the good wear resistance exhibited by zinc alloys. Hence these alloys are used in moderately demanding applications where their natural bearing properties can be exploited.
- **Fatigue** is one of the most frequent failure mechanisms in components. Zinc, like other diecast metals, is between 7 to 10 times more resistant to fatigue than ABS.
- The **K_{IC} Fracture Toughness** of diecast zinc and other metals is around 10 to 30 times greater than that of engineering plastics.

Zinc diecastings have much to offer the designer when the going gets tough.



seat belt
COURTESY OF CAST METALS FEDERATION

door gear box
COURTESY OF FÖHL

Consistency

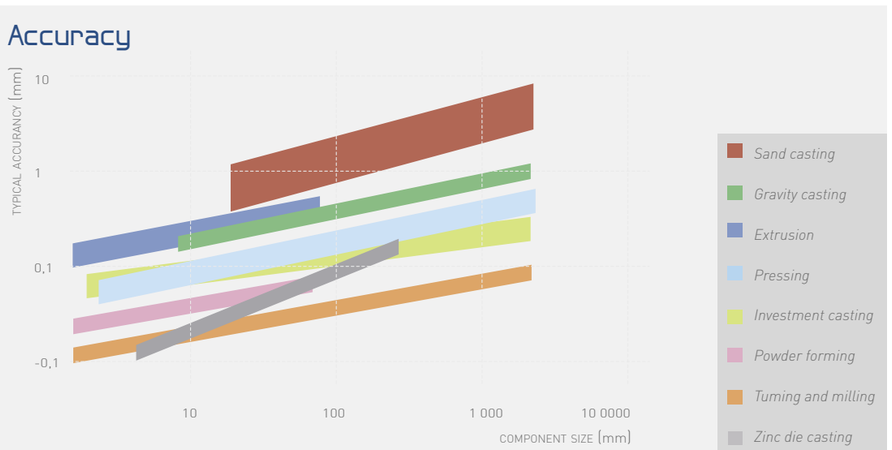
HOT CHAMBER ZINC ALLOY DIECASTING IS THE ONLY LOW COST, HIGH-VOLUME, PROCESS ABLE TO MANUFACTURE THREE DIMENSIONAL COMPONENTS TO TIGHTER AND MORE CONSISTENT TOLERANCES.

- **Pressure diecastings are 5 to 10 times more accurate than products made by other processes** such as pressing, gravity casting or powder forming. They can compare to turning or milling. Within pressure diecasting, **zinc alloy castings are 2 to 4 times more accurate than those made from magnesium and aluminium alloys**. High solidification shrinkage and water absorption make close tolerances in plastics difficult to achieve.

- The exceptional accuracy, predictability and repeatability obtained from the zinc die casting process are not only evident within single production runs, but between separate production runs too. Surface quality consistency is excellent due to the extremely low rate of tool surface degradation securing **your own reputation for quality**.

For example, in an industry survey, best dimensional consistency across 'within the mould' features (greater than 25 mm across) could be cast to a Sigma 8 consistency of 0.1%, or less, of the dimension measured.

75% of features measured, were found to be cast to a Sigma 8 consistency of less than 0.5% of the dimension measured. If discussed early with your zinc diecaster, a Sigma 8 consistency of 0.2% may be held without excessive die adjustment or process control.



electronic connectors
COURTESY OF CAST METALS FEDERATION

gearbox housing
COURTESY OF DRUMETA

turbine housing
COURTESY OF SIOBRA

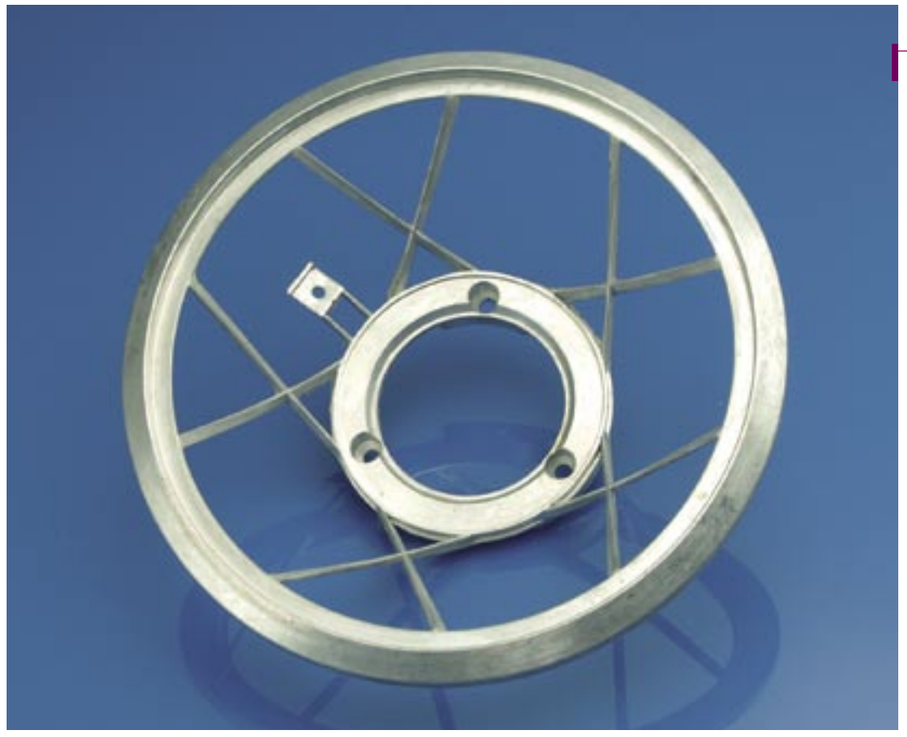
‘Hidden’ Bonus Properties

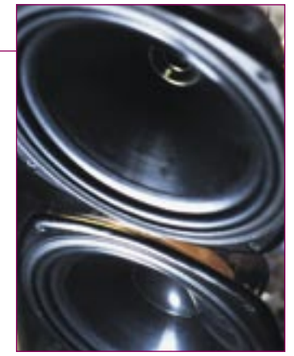
ZINC ALLOY DIECASTINGS WILL ENHANCE YOUR PRODUCTS AND BRAND MORE THAN YOU MIGHT EXPECT:

- The **damping capability of zinc alloys** - their ability to absorb energy and sound caused by externally induced mechanical vibration - is comparable to magnesium, and is 5 to 10 times greater than aluminium.
- The **thermal conductivity** of zinc alloys is much better than cast LM24 or Aluminium 380 and far more superior to Magnesium AZ91D. Such advantages combined with thin wall diecasting of integral cooling fins in zinc, can make a big difference if **heat dissipation** in confined spaces is important.
- The **shielding of sensitive electronic equipment from electromagnetic interference** is excellent. Metal diecast enclosures are inherently shielding unlike plastics. Equally important is the prevention of leakage at joints. The tight tolerance levels of zinc alloys provide reliability and consistency.
- Unlike plastics and some other materials, zinc will not normally sustain fire during processing or use. It is a **relatively fire safe** material.
- As **‘non-sparking’ alloys**, because all hot chamber diecasting zinc alloys contain less than 15% by weight in total of aluminium, magnesium and titanium, zinc alloys are safe when struck accidentally in hazardous or gaseous environments, including those underground.

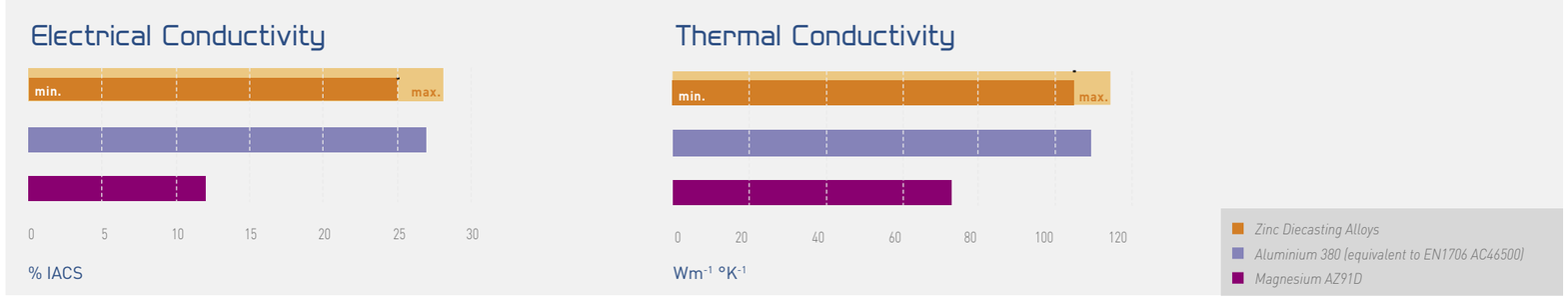
Zinc diecastings offer optimal protection **from noise, vibration, heat, radiation, explosion and fire.**

loud speaker
COURTESY OF CAST METALS FEDERATION





lighting parts/lamp parts
COURTESY OF MATTHIES



Intrinsic Economic Advantages

THE HOT CHAMBER ZINC DIECASTING PROCESS OFFERS MINIMUM PROCESSING COSTS:

- **Production time savings:** This process combined with the relatively low casting temperature needed for zinc alloys allows exceptionally high production rates. For medium sized zinc components, 400 to 1000 shots per hour are common. Extremely small detailed zinc castings can be produced at up to 3500 shots per hour on specialised machines. By comparison, typical shot speed ranges for medium sized aluminium, magnesium and plastic components from 100 to 250, 200 to 300 and 100 to 300, respectively.

- **Energy savings:** For the same number of same size diecastings, aluminium will use at least 50% more energy than zinc, while magnesium will need at least 15% more energy per casting than zinc. This is in addition to the high energy requirements needed to produce the aluminium and magnesium.

- **Near Net Shape castings:** Clever design of product and tool, combined with zinc alloy's inherent accuracy and excellent surface, can result in **Near Net Shape zinc castings** that require, if any, just the minimum of further processing stages.

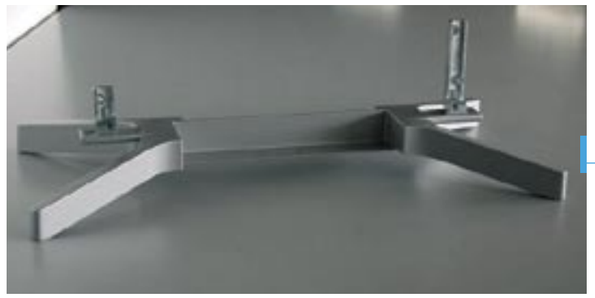
- **Easy to assemble:** If required, the high ductility of zinc will allow parts to be distorted in a controlled manner to achieve a final desired shape, or be inexpensively joined to an adjacent component, through bending, forming, spinning or heading.

- **Low tooling wear:** For large volumes, zinc offers considerable further cost savings because its **tooling typically lasts between 750,000 shots to 2 million** shots. Aluminium and magnesium will struggle to achieve 250,000 and 500,000 shots respectively.

- **Safety:** Users of zinc diecastings will not have to absorb the costs of the special problems related to magnesium's fire risks, aluminium's post casting leak proofing or plastic's water absorption.

Hot Chamber Zinc Diecasting is the most cost efficient production technique for 3D components due to its production speed and the low volume of scrap produced.

silicon pistol
COURTESY OF CAST METALS FEDERATION



TV set deskfoot
COURTESY OF BRUSCHI

TV set with deskfoot
COURTESY OF BRUSCHI

A Properties Guide to Modern Zinc Alloys and other selected Materials

PROPERTY	UNITS	ZP3	ZP5	ZP2	ZP8	LM24	A380	AZ91D	ABS	NYLON PA66	NYLON PA66 30% GR	POLY-CARBO-NATE	ACETAL
Yield Strength	MPa	268	295	361	319	150	159	111-170	n/a	n/a	n/a	n/a	-
Ultimate Tensile Strength	MPa	308	331	397	387	320	317-324	200-260	25-65	71-85	155-210	54-72	37-70
Youngs Modulus	GPa	96	96	96	96	71	71	44	1.4-5.1	0.7- 4.1	3.2-12.7	1.6-5.5	1.4-3.6
Torsional Modulus	MPa x 10^3	33+	33+	33+	33+	26.9	26.9	16.5	n/a	n/a	n/a	n/a	-
Elongation at Fracture	%	5.8	3.4	6	3.4	2	3.5	3	2-110	15-300	2.0 -150	8-135	3-250
Shear Strength	MPa	214	262	317	275	-	186	138	-	-	-	-	-
Compressive Yield Stress	MPa	414	600	641	600 appr.	-	-	108-159	-	-	-	-	-
Impact Resistance	Joules	46	52	38	42	3.4	4	3.7-6	1-2	0.6-1.4	5	20-30	8
Fatigue Resistance (5.10^8 cycles)	MPa	48	57	59	51.5	-	70-138	97	7	-	15	7	-
Hardness	Brinell	97	114	130	110	85	80	63-85	too soft	too soft	too soft	too soft	-
Fracture Toughness Kic	x 10^7N.$m^{-3/2}$	2.25	2.1	-	1.95	3.6	3.6	-	-	0.07	-	0.22	0.09
Density	g/cm^3	6.6	6.7	6.8	6.3	2.79	2.76	1.82	1.02-1.21	1.03-1.16	1.11-1.68	1.17-1.45	1.29-1.43
Spec Damping Capacity @ 35 MPa	%	18	-	-	20	-	1	25	-	-	-	-	-
Spec Damping Capacity @ 100 MPa	%	40	-	-	44	-	4	53	-	-	-	-	-
Coeff of Thermal Expansion	µm/m/°C	27.4	27.4	27.8	23.3	21	21.1	25.2-26.0	50-150	65-150	17-104	32-20	12-162
Thermal Conductivity	Wm^{-1} $°K^{-1}$	113	109	105	115	96	109	51-72.7	0.2	0.24	<1	<1	0.13-0.3
Electrical Conductivity	% IACS	27	26	25	27.7	24	27	11.5-12.1	n/a	n/a	n/a	n/a	n/a
Electrical Resistivity	µ ohm - cm	6.37	6.54	6.85	6.2	-	-	-	-	-	-	-	-
Melting Temperature Range	°C	381-387	380-386	379-390	375-404	520-580	538-593	468-598	-	-	-	-	-
Specific Heat Capacity	J/kg/°C	419	419	419	435	960	960	1020	1960-2130	1600-2750	1200-2350	1000-1200	-
Coeff of Friction	-	0.07	0.08	0.08	0.11	-	-	-	0.45	0.28-0.46	0.28	0.38	0.21
Typical Precision over 100 mm	plus/minus µ	100	100	100	100	250-350	250-350	175	High shrinkage and humidity make close tolerances difficult for plastics				
Min Wall Thickness	mm	0.4	0.4	0.4	0.4	1.3	1.3	1.2	-				
Typical Production Speeds	shots per hour	Large 200-500. Small 400-1000. Tiny 2000-3000.				50-250		Typical 200-275. About 2 thirds Zn, size for size.	Production speeds governed largely by product size, material used and rate of cooling, which, size for size, tends to be far slower than metals				
Broad Production Speed Range	shots per hour	200-3600				30-350		40-2400	Injection moulding speeds 100 to 400 shots per hour				
Typical Tool Life	shots	750,000-2,000,000				100,000-225,000		300,000-500,000	Highly dependent on composition and reinforcement				

The data in this table is provided for information only. It is therefore not to be considered as a binding statement by the author (copyright holder).

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A website dedicated to advancing the knowledge of Zinc Die Casting.

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