Description

Image

Caption

1. Shaver body. © Chris Lefteri 2. Carburetor body made using zinc die-casting. © Granta Design

The material

Zinc is a bluish-white metal with a low melting point (420 C). The slang in French for a bar or pub is "le zinc"; bar counters in France used to be clad in zinc - many still are - to protect them from the ravages of wine and beer. Bar surfaces have complex shapes - a flat top, curved profiles, rounded or profiled edges. These two sentences say much about zinc: it is ductile; it is hygienic; it survives exposure to acids (wine), to alkalis (cleaning fluids), and to misuse (upset customers). These remain among the reasons it is still used today. Another is the "castability" of zinc alloys - their low melting point and fluidity gives them a leading place in die-casting.

Compositional summary

Zn + 3-30% Al, typically, often with up to 3%Cu

General properties

Density		309	-	437	lb/ft^3
Price	*	1.22	-	1.25	USD/lb
Date first used		1849			

Mechanical properties

Young's modulus		9.86	-	14.5	10^6 psi
Shear modulus	*	3.63	-	5.8	10^6 psi
Bulk modulus		7.25	-	13.1	10^6 psi
Poisson's ratio	*	0.25	-	0.33	
Yield strength (elastic limit)		11.6	-	65.3	ksi
Tensile strength		19.6	-	74	ksi
Compressive strength		11.6	-	65.3	ksi
Elongation		1	-	30	% strain
Hardness - Vickers		55	-	160	HV
Fatigue strength at 10^7 cycles	*	2.9	-	23.2	ksi

Fracture toughness	* 9.1	-	63.7	ksi.in^0.5
Mechanical loss coefficient (tan delta)	* 6e-4	-	0.006	

Thermal properties

Melting point	707	-	917	°F
Maximum service temperature	* 176	-	230	°F
Minimum service temperature	-67.3	-	-45.7	°F
Thermal conductor or insulator?	Good conductor			
Thermal conductivity	57.8	-	75.1	BTU.ft/h.ft^2.F
Specific heat capacity	0.0967	-	0.128	BTU/lb.°F
Thermal expansion coefficient	12.8	-	15.6	µstrain/°F

Electrical properties

Electrical conductor or insulator?	Good conductor			
Electrical resistivity	5.4	-	7.2	µohm.cm

Optical properties

Transparency	Opaque			

Processability

Castability	5			
Formability	2	-	3	
Machinability	5			
Weldability	1			
Solder/brazability	4	-	5	

Eco properties

Embodied energy, primary production	* 6.2e3	-	6.85e3	kcal/lb
CO2 footprint, primary production	* 3.9	-	4.31	lb/lb
Recycle	✓			

Supporting information

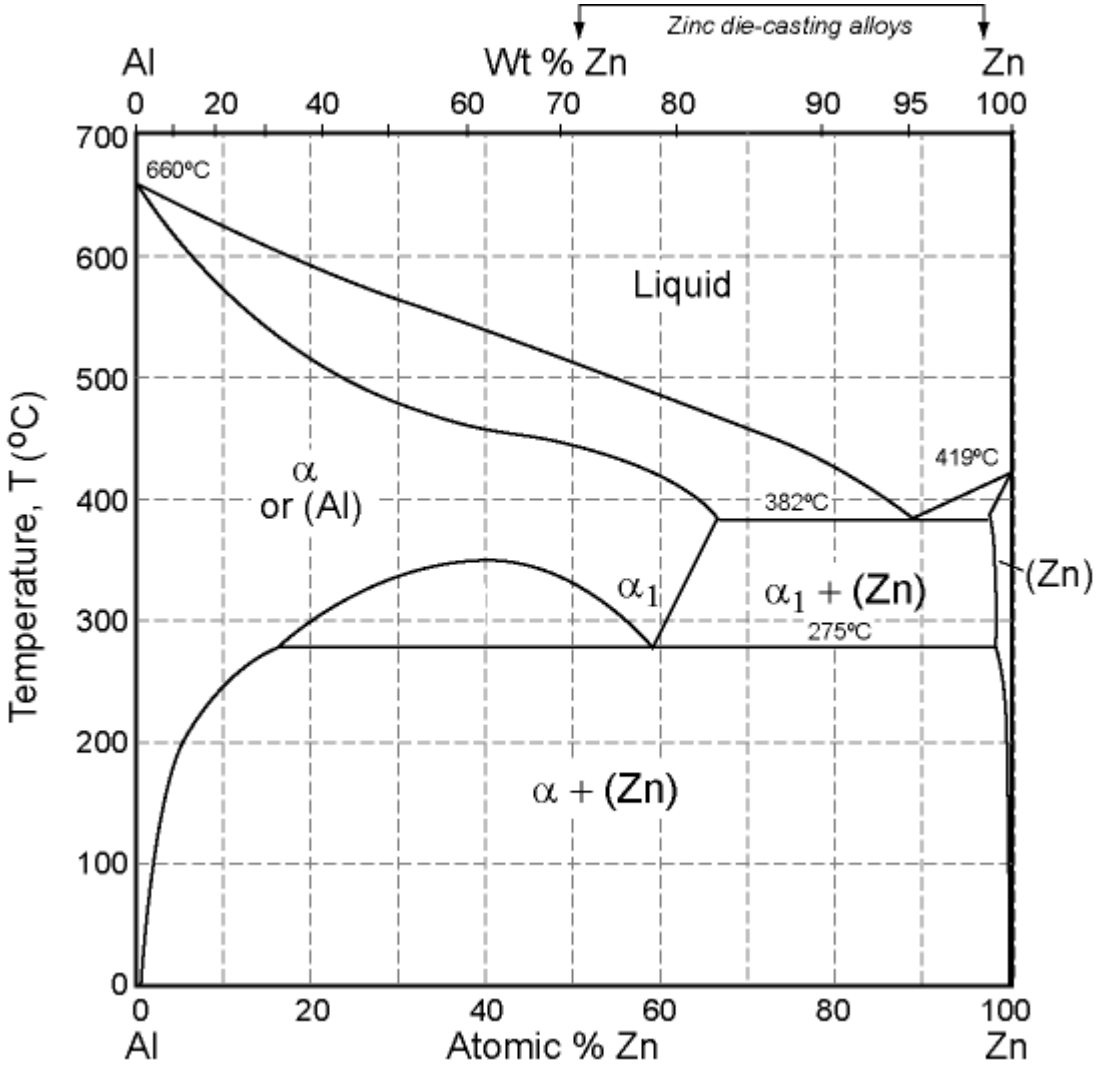
Design guidelines

Zinc die-casting alloys are strong enough for most consumer products; and the metal itself is cheap (they are the metallic answer to injection molded polymers). As die castings, zinc alloys offer higher strength than other die-casting alloys except those of copper. Die cast parts can be held to close tolerances, in thin sections and are easily machined, though little may be needed. They can be of complex shape: car carburetor bodies, "Dinky" toys (model cars) and small gears are examples.

Technical notes

Most zinc alloys are die cast; for this, the prime alloys are AG40A and AC41A. Superplastic zinc alloys can be formed by methods normally used for polymers - vacuum forming, compression molding - as well as traditional metal processes like deep drawing and impact extrusion. Extrusion and forging is done with zinc-manganese alloys.

Phase diagram



Phase diagram description

Zinc die-casting alloys are based on zinc (Zn) with 3 - 30% aluminum (Al), for which this is the phase diagram. Many also contain up to 3% copper.

Typical uses

Die castings; automotive parts and tools; gears; household goods; office equipment; building hardware; padlocks; toys; business machines; sound reproduction equipment; hydraulic valves; pneumatic valves; soldering; handles; gears; automotive components.

Links

Reference

ProcessUniverse

Producers