UNIT IV FERROUS AND NON FERROUS METALS

Magnesium (Mg) Alloys

Engineering Materials and Metallurgy

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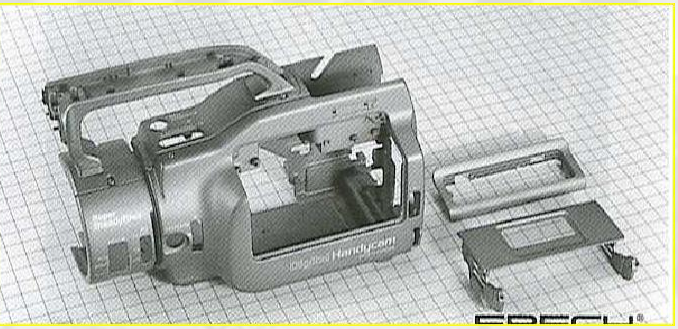
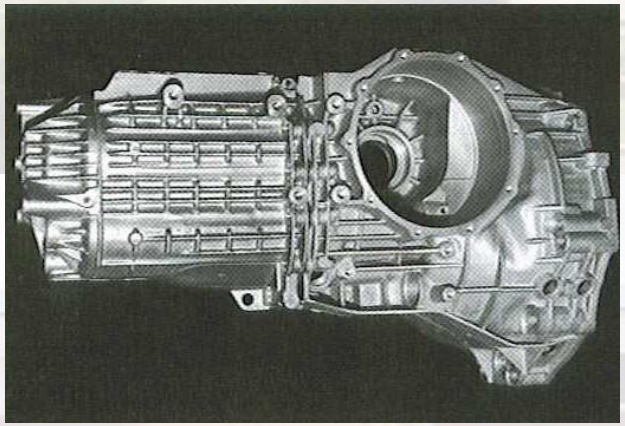
INTRODUCTION – APPLICATIONS



Cam and mobile phone bodies.

Magnesium side panels

Alloyed wheel



Gearbox housing in the VW-Passat

Aerospace applications

PHYSICAL PROPERTIES OF MAGNESIUM

Crystal structure Atomic diameter	HCP 0.320	a = 0.3202, c = 0.5199, c/a = 1.624 easily alloyed with Al, Zn, Ag, Zr
Density ($g.cm^{-3}$)	1.74	
Melting point (^oC)	650	

- Alloyed with Al, Zn, Mn, rare earth metals to produce alloys with high-strength-to weight ratios.
- Not readily plastically deformed at RT due to HCP structure.
- Cast magnesium alloys dominate 85-90% of all magnesium alloy products, with Mg-Al-Zn system being the most widely used.

- Low strength and toughness and corrosion resistance.
- Easily flammable with oxygen.

→ Limit applications of magnesium alloy

COMMERCIAL MAGNESIUM ALLOYS

- Mg-Al casting alloys
- Mg-Al-Zn casting alloys
- Mg-Zn and Mg-Zn-Cu casting alloys
- Mg-Zn-Zr and Mg-RE-Zn-Zr casting alloy
- High temperature Mg casting alloys
- Wrought Mg alloys

Mg-Al CASTING ALLOY

- Al is alloyed to increase strength, castability and corrosion resistance.

- Maximum solid solubility is ~ 12.7% at 473^{o}C.

- Light weight and superior ductility.

Mg-Al-Zn casting alloys

- Light weight, strength and relatively good corrosion resistance and easily cast.
- *Zn addition* increases strength by *solid solution strengthening* and *precipitation hardening*.
- σ_{TS} ~ 214-241 MPa with 1-8% elongation.

Mg-Zn and Mg-Zn-Cu CASTING ALLOYS

Mg-Zn *alloy*

- Response to age hardening
- Susceptible for microporosity.

Mg-Zn-Cu alloy

Cu addition notably improves ductility and large response to age hardening.

σ_y ~130-160 MPa, σ_{TS} ~215-260 Mpa

- Ductility 3-8%.

Cu addition also raises eutectic temp and give maximum solution of *Zn* and *Cu*.

HIGH-TEMPERATURE MAGNESIUM CASTING ALLOYS

- Primarily used for aerospace applications due to light weight (major consideration).
- Application range 200-250^{o}C with tensile strength ~240 MPa.
  - Mg-Ag-RE alloys
- QE22 has been used for aerospace applications, i.e., landing wheels, gear box housings.
  - Mg-Y-RE alloys
- WE43 has been developed for improved elevated temperature tensile properties.
  - Mg-Ag-Th-RE-Zr alloys
- Thorium is best known to improve high temperature properties, due to age hardening and refined grain but slightly radioactive € not commercially available.

WROUGHT MAGNESIUM ALLOY PRODUCTS

Extruded parts

Profiles of variable cross-section

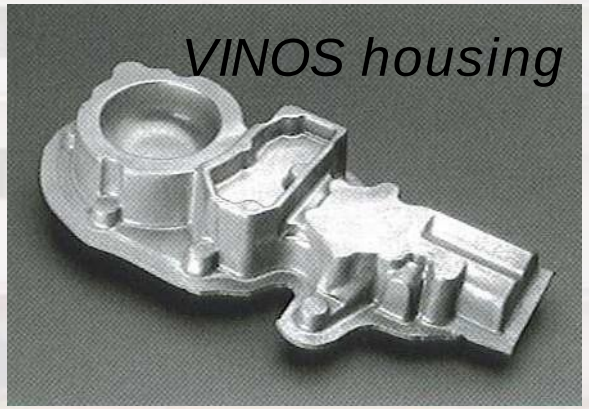
A profile of large cross-section (6m long)

Anterior bars of vehicle

Extruded parts

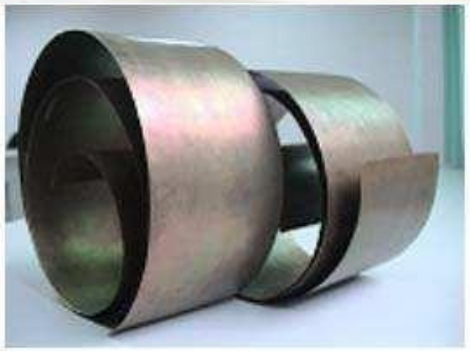
Dirtworld.com

Sport device



VINOS housing

Forged parts



Magnesium strips

Magnesium sheet (1500×1.8mm)

Sheet, strips

ENGINEERING DESIGN WITH MAGNESIUM ALLOYS

Advantages of Magnesium Alloys for Engineering Designs:

1. Ability to die cast at high productivity rate.
2. Good creep resistance to 120^{o}C.
3. High damping capacity due to ability to absorb energy elastically.
4. High thermal conductivity permitting rapid heat dissipation.
5. Good machinability.
6. Easily gas-shield arc-welded.

Disadvantages of Magnesium alloys for Engineering Designs:

1. High tendency to galvanic corrosion when contact with dissimilar metals or electrolyte.
2. Difficult to deform by cold working.
3. High cost.

THANK YOU