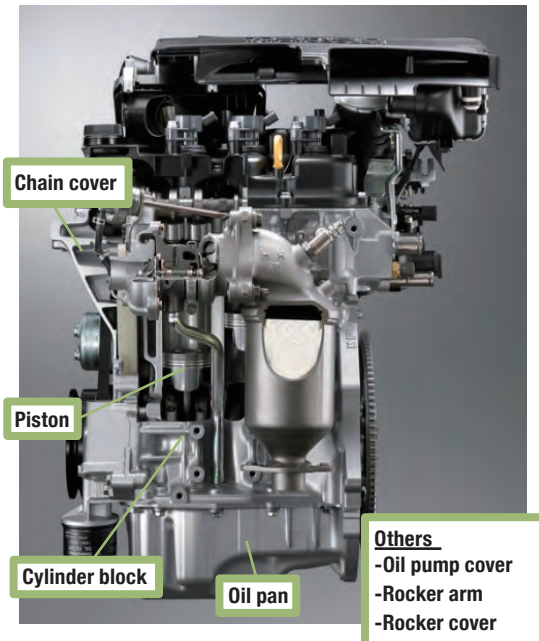
Tobata Seisakusho Co., Ltd.

Heat-resistant and Non-combustible Magnesium Alloy

Development of engine members using the casting technique of heat-resistant and non-combustible magnesium alloy



Others
-Oil pump cover
-Rocker arm
-Rocker cover
-Engine bracket, etc.

In order to achieve higher fuel-efficiency and lower vibration and noise in automobiles, we developed magnesium alloy members having heat-resistance and abrasion-resistance that are usable as engine parts, without using costly materials such as rare earths.

2009-2011 METI Strategic Foundational Technology Improvement Support Operation (Supporting Industry Project)
R&D organizations: Fukuoka Industry, Science & Technology Foundation (management body), Tobata Seisakusho Co., Ltd., Daihatsu Metal Co., Ltd., Kyushu University, National Institute of Advanced Industrial Science and Technology, Fukuoka Industrial Technology Center

Piston for automobile engine

・Accomplished 50-hour full-load operation test.
(Result of Supporting Industry Project)

Piston for general engine

・Evaluation with general engine is almost finished.
・Engine vibration of a weed cutter and a chain saw was reduced by 20%.

Product development & design: Daihatsu Metal Co., Ltd.

【Conventional technology】 → 【New technology】

〈Aluminum alloy members〉

Challenges

・Since most of pistons are made of aluminum alloy and the shapes are already optimized, there is no room to reduce weights.
・To solve friction and seizing problems, tinning and alumite treatment are applied depending on the site and heat load.

〈Heat-resistant and Non-combustible magnesium alloy members〉

Features

・Light-weight, high attenuation capacity and low friction coefficient.
・Higher heat resistance compared with traditional casting alloy (AZ91).
・Stable supply with low cost due to the recycling technique and no use of rare earths.

We established the production and recycling techniques of heat-resistant casting members using magnesium alloy.

"Magnesium alloy with heat resistance and non-combustible, and method of manufacturing the same" (Patent publication number: 2013-019030)

Development of heat-resistant alloy → **Hardness: 118HV / Elevated temperature tensile strength: 130MPa(250℃)**

The hardness of 118HV was achieved by adding silicon to non-combustible magnesium alloy.
Also, we established the inclusion control method by calculating the allowable defect size to fulfill the tensile strength of 130MPa.

Establishment of inclusion control method → **Thermal fatigue strength: 63MPa (250℃) / No defect at stress concentration point**

We established the casting method by calculating the allowable defect size to fulfill fatigue strength 63MPa (250℃) at stress concentration point, by evaluating solidified structures through observation and instrumental analysis and by examining the simulation analysis and prototypes.

Establishment of recycling technique → **Recycled material use rate is 60%**

We achieved 60% of recycled materials use rate by applying quality control standards that include oxide inclusion ratio estimated by oxygen analysis, and metal impurities of recycled materials.

Shape optimization design → **Reductions of weight, vibration and noise were verified.**

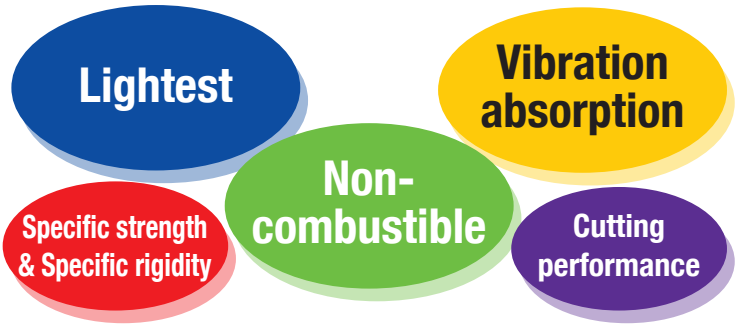
In the evaluation using actual equipment, the high strength of alloy in high-temperature range was verified.
Reductions of weight, vibration and noise were verified and consistent with the theory.

Tobata Seisakusho Co., Ltd.

Non-combustible Magnesium Alloy

Features of non-combustible magnesium alloy

Traditional images of magnesium alloy,easy to flammable at low ignition temperature, is now overturned.



Lightest

Lightest among practical alloys with a specific gravity of 1.8, about 2/3 of aluminum alloy and 1/4 of steel.

Vibration absorption (attenuation capacity)

Having the largest vibration absorption (attenuation capacity) among practical metals, vibration and noise can be successfully reduced.
Attenuation capacity: 267 times of Al (in case of pure Mg)

Specific strength & Specific rigidity

Possible to produce lighter-weight products for the same specification due to its higher specific strength/rigidity compared with aluminum alloy and steel.

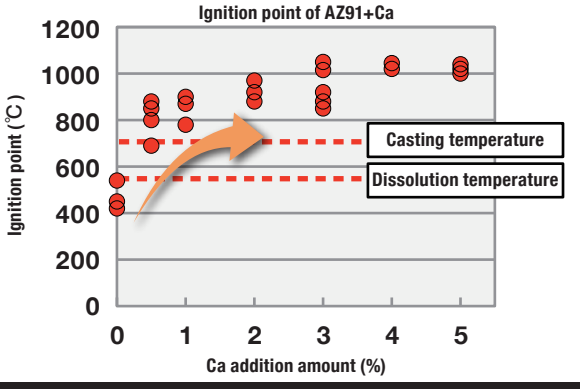
Cutting performance

As its cutting resistance is about 1/2 of aluminum alloy and 1/5 of mild steel, reduction of process time and extension of tools lifetime are possible.

Non-combustible

【Ignition point of non-combustible magnesium alloy is higher than 900℃】
Ignition point of general alloy is near melting point (about 600℃).

Rise of ignition point after Ca added



Easy to handle in melting and casting processes

・No need for flux and inactive gas(SF_6) that has a high global warming potential (Global warming potential: 23,900 times of CO_2) ⇒ Environmentally friendly
・No need for a special facility.
・Existing aluminum melting facility can be used.

Easy cutting and processing

・Dry processing is possible.
・Easy to handle chips after cutting.
・It is possible to recycle chips.

Seeds development by National Institute of Advanced Industrial Science and Technology (Patented)

・Patent-3318606 "Production of calcium-containing magnesium alloy casting"
・Patent-3030338 "Production of high strength Non-combustible magnesium alloy"

Technical transfer ⇒ Tobata Seisakusho Co., Ltd.

◆Non-combutible magnesium alloy products

・Ingot
・Billets for extrusion processing
・Sand casting
・Metal mold casting
・Die-casting

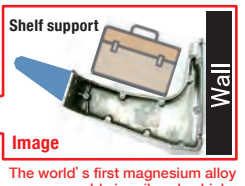
We respond to variousneeds such as small-lot, test products, etc.

◆Applications of non-combutible magnesium alloy

As a structural material

Interior member of high-speed trains

Photo: website of Central/West JR



The world' s first magnesium alloy usable in railroad vehicle.

Taking advantage of its light-weight and high specific strength/rigidity, it is in practical use as a shelf support.

As a functional material

Magnesium air battery (negative-electrode material)

Magnesium air battery has not been realized because of problems including the short lifetime due to self-discharge (a reaction not by battery reaction), ignition risks and high costs. In this project, we are working for the production technique of alloy with high-efficiency and ignition-inhibition features realizing thinner plate thickness and lower costs.

2013-2015 METI Strategic Foundational Technology Improvement Support Operation (Supporting Industry Project)
R&D organizations: Kitakyushu Foundation for the Advancement of Industry, Science and Technology (management body), Tobata Seisakusho Co., Ltd., Furukawa Battery Co., Ltd., Fuji Light Metal Co., Ltd., National Institute of Advanced Industrial Science and Technology