

## Key R&D activities for development of new types of wrought magnesium alloys in China

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**Abstract:** Many researchers in China are actively engaged in the development of new types of wrought magnesium alloys with low cost or with high-performances and novel plastic processing technologies. The research activities are funded primarily through four government-supported programs: the Key Technologies R&D Program of China, the National Basic Research Program of China, the National High-tech R&D Program of China, and the National Natural Science Foundation of China. The key R&D activities for the development of new wrought magnesium alloys in China are reviewed, and typical properties of some new alloys are summarized. More attentions are paid to high-strength wrought magnesium alloys and high-plasticity wrought magnesium alloys. Some novel plastic processing technologies, emerging in recent years, which aim to control deformation texture and to improve plasticity and formability especially at room temperature, are also introduced.

**Key words:** wrought magnesium alloy; microstructure; properties; alloy designing; plastic deformation; research projects

### 1 Introduction

In the past years, the annual output of magnesium has increased remarkably in China, and magnesium alloys are being applied to motorcycles, automobiles, electric devices and so on. However, more extensive application has not yet commenced due to the high cost of sheets and profiles of wrought magnesium alloys and their unsatisfactory properties. Nowadays, the research and development (R&D) on high-performance wrought magnesium alloys and novel forming processes have received much more global attention than ever before, and many R&D projects have been supported by the central government and local government.

In China, the research on wrought magnesium alloys is mainly conducted in Chongqing University (CQU), Shanghai Jiao Tong University (SJTU), Institute of Metal Research of Chinese Academy of Sciences (IMR), Changchun Institute of Applied Chemistry of

Chinese Academy of Sciences (CIAC), Central South University (CSU), etc. Research funding primarily come from four government-supported programs, namely, the Key Technologies R&D Program, the National Basic Research Program of China, the National High-Tech R&D Program of China, and the National Natural Science Foundation of China. In the present work, the key R&D activities on wrought magnesium alloys in China, including arrangement of national research projects for wrought magnesium alloys and development of new types of wrought magnesium alloys and novel plastic processing technologies, are introduced and discussed.

### 2 R&D projects on wrought magnesium alloys in China

#### 2.1 Projects under the National Key Technologies R&D Program

The Key Technologies R&D Program is the first

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national science and technology (S&T) program in China. It aims to address major S&T issues on national economic construction and social development. Initiated in 1982 and implemented through 4 Five-year Plans, the program has made remarkable contributions to the technical renovation and upgrading of traditional industries and the formation of new industries.

At the beginning of this century, Chinese government has started two rounds of (two Five-year Plans from 2000–2010) R&D projects for magnesium and its applications (shown in Table 1) under the Key Technologies R&D Program of China. With the guidance of the Ministry of Science and Technology (MOST), Chinese magnesium industry made rapid progress through these projects. A complete industrial production chain, including primary magnesium and its alloy making, die-casting, extruding, rolling, welding, surface protection was set up. The annual output of Chinese primary magnesium increased stably step by step and reached 627 300 t in 2007, about 70% of the world output. The amount of various magnesium alloy products used in automobiles, motorcycles, bicycles, and 3C electronics increased rapidly, and the application field of magnesium expanded quickly as well. It can be seen from Table 1 that most of the sub-projects under this programme are related to development and application of processing technologies of wrought magnesium alloys.

## 2.2 Projects under the National Basic Research Program

In 2007, the National Basic Research Program of

magnesium alloys titled “Key Basic Problems during Preparation and Processing of High Performance Magnesium Alloys” organized by Chongqing University was approved, and the total fund is 31 million RMB Yuan. Many universities and institutes in China have joined this project. This project is closely related to great national strategic demand, and aims to solve the key technological bottleneck of preparation and processing of high-performance wrought magnesium alloys. The key scientific problems, research sub-subjects as well as general objectives can be seen in Table 2.

Some important innovative research results related to the basic problems by this project have been obtained in the past two years, including:

- 1) new purification flux and electromagnetic semi-continuous casting technique;
- 2) influence of initial grain and temperature on deformation behavior;
- 3) mechanism of the competition between dislocation slip and twinning;
- 4) grain refinement;
- 5) law of second phase strengthening and toughening;
- 6) optimized combination of strength and damping capacity.

These obtained results provide direct technological support for extrusion of the profiles with large cross section and processing technique of large-dimension sheets. Through these projects, about 130 papers have been published and 53 patents have been applied.

**Table 1** Projects on Mg and its alloys supported by the National Key Technologies R&D Program

Project	Year	Fund/10 <sup>6</sup> USD	Research sub-project
Application and key technologies of Mg and its alloys	2000–2005	10	Mg metallurgical technologies and equipments
			Mg die casting and its application in automobile industry
			Mg extrusion and its product development
			Mg sheet rolling and its application in 3C products
			Mg welding and surface protection
			Mg refining and recycling technologies and equipments
			Processing and application of MgO products
			Development and industrialization of Mg die casting equipment and its gas-protection system
Key technologies development and application of Mg and its alloys	2006–2010	6	High quality Mg alloy processing technologies
			Advanced processing technologies of Mg sheet production
			Low-cost processing technologies of Mg profile production
			Complex Mg castings and integrated processing technologies
			Welding and surface protecting technologies of Mg alloys
			Advanced technological development for Mg electrolyzing and anhydrous MgCl <sub>2</sub> processing
			Mg metallurgical production by silicon reduction with energy-saving and environment-protecting
			Special deformation technologies of Mg alloy products and basic standardization system for Mg researches and industrialization

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