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Chapter 1

Introductory Chapter: Magnesium Alloys

Tomasz Tański and Mariusz Król

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1. Introduction

Today the development of techniques and technologies makes it necessary to look for new design solutions which aim to improve efficiency, product quality and reliability. Before selecting the material, the analysis of requirements is carried out. The demand for using materials with the lowest density and good properties has been increasing for years [1, 2].

Currently trends in the development of techniques tend to reduce the weight of finished products, machines or constructions. This is dictated by ecology and reduced energy consumption. It also results in a growing interest in low-density materials, mainly magnesium and its alloys [1–3].

Magnesium is an element constituting 2.74% of the Earth's crust. It occurs in most countries in the form of various compounds and minerals. The most common ores are dolomites ($MgCO_3 \cdot CaCO_3$) and magnesites ($MgCO_3$). Another mineral used for the magnesium production is carnallite. Magnesium is also included in serpentine. Oceans are a rich source of magnesium, which contain approx. 0.13% of the metal in the salt solution as $MgCl_2$ and $MgSO_4$. In 1808, the electrolysis of molten salts allowed Humphrey Davy, an English chemist, to extract pure active metals for the first time, including magnesium [4–6].

A French chemist Antoine Bussy, on the other hand, developed another method of producing metallic magnesium. He published in Mémoire sur le Radical métallique de la Magnésie (1831) the process of obtaining magnesium which involves heating magnesium chloride ($MgCl_2$) and potassium (K) in the retort [1, 3, 4].

After dissolving potassium chloride (KCl) formed as a result of the reaction, pure magnesium remained in the retort. In the mid-nineteenth century, this method allowed magnesium production in Paris and Manchester which was initially almost entirely devoted to photography. Metallic magnesium was obtained in the form of a wire or powder. In 1852, Robert Bunsen using the Davy's concept constructed a bath for the electrolysis of molten magnesium chloride. Several years later, in 1886, the production of magnesium began in Germany using the modification of the Bunsen's bathtub. This process was jointly undertaken by Chemische Fabrik Griesheim-Elektron and Aluminium and Magnesium Fabrik on an industrial scale in 1896. What is more, between 1914 and 1915, it was the only major magnesium producer in the world [2].

Due to low mechanical properties, the element itself is not used as a construction material. Magnesium alloys, however, are completely different. They present much better mechanical and strength properties taking special care to maintaining their most important low-density advantage through various modifying treatments. The interest in these rates dates back to the beginning of the twentieth century. Classical magnesium alloys are a combination of aluminium, magnesium, manganese and zinc. Magnesium combined with lithium forms ultralight alloys that have many uses. Since it is a reasonable material, it offers great possibilities and is constantly tested at various angles of applications and properties [2–4].

A few decades ago, magnesium alloys were used mainly for military purposes. Today due to the development in plastic deformation, heat treatment and manufacturing (e.g. cooling by high cooling rate, thixocasting), they are used in other fields, such as the automotive or aerospace industries.

In addition to low density, they exhibit many other benefits, such as good corrosion and castability, high dimensional stability and resistance to shocks and impacts, low shrinkage, the ability to be applied to 300°C elements as well as the ease of welding and recycling [4–7].

Magnesium, previously used for military purposes, seems to fit perfectly to the requirements of the currently prevailing technology. Low density, with appropriate mechanical properties (strength, high operating temperature), good foundry properties (high castability and low shrinkage), vibration damping ability, and cost-effectiveness of recycling, seem to be an ideal response to market needs [1–3, 7].

All things considered, magnesium alloys are the perfect material used in various industries starting from the automotive industry, through sport, electronics up to the space industry and defence.

That work was developed by experts in various areas of magnesium science and technology. It gives a general idea of modern advancements in theory and practical purposes of magnesium alloys. The book reports fundamental aspects of corrosion types, details about magnesium alloys designed to work in elevated temperature and superplastic behaviour. Fundamentals, broad experience, theory as well as complex technological aspects make this work helpful for engineers and scientists from all over the world.

Author details

Tomasz Tański* and Mariusz Król

*Address all correspondence to: tomasz.tanski@polsl.pl

Institute of Engineering Materials and Biomaterials at Silesian University of Technology, Poland

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