Progress in Materials Science 89 (2017) 92–193

Contents lists available at ScienceDirect

Progress in Materials Science

journal homepage: www.elsevier.com/locate/pmatsci

Fundamentals and advances in magnesium alloy corrosion

M. Esmaily [a,*], J.E. Svensson [a], S. Fajardo [b,c], N. Birbilis [d], G.S. Frankel [b], S. Virtanen [f], R. Arrabal [e], S. Thomas [d], L.G. Johansson [a]

[a] Department of Chemistry and Chemical Engineering, Chalmers University of Technology, Gothenburg 412 96, Sweden
[b] Fontana Corrosion Center, Department of Materials Science and Engineering, The Ohio State University, Columbus, OH 43210, USA
[c] Department of Surface Engineering, Corrosion and Durability, National Center for Metallurgical Research (CENIM-CSIC), Madrid 28040, Spain
[d] Department of Materials Science and Engineering, Monash University, Victoria 3800, Australia
[e] Departamento de Ciencia de Materiales, Universidad Complutense, Madrid 28040, Spain
[f] Department of Materials Science (LKO, WW-4), University of Erlangen-Nuremberg, 91058 Erlangen, Germany

A R T I C L E I N F O

Article history:
Received 26 November 2016
Received in revised form 30 March 2017
Accepted 22 April 2017
Available online 15 May 2017

Keywords:
Mg
Electrochemistry
Atmospheric corrosion
Alloying
Composites
Biodegradable alloys

A B S T R A C T

There remains growing interest in magnesium (Mg) and its alloys, as they are the lightest structural metallic materials. Mg alloys have the potential to enable design of lighter engineered systems, including positive implications for reduced energy consumption. Furthermore, Mg alloys are also emerging as viable biodegradable materials and battery electrodes. In spite of the greatest historical Mg usage at present, the wider use of Mg alloys remains restricted by a number of inherent limitations, including vulnerability to corrosion, poor formability and low creep resistance. This review covers recent research that has led to advances in Mg-alloy corrosion; including the application of contemporary methods for understanding Mg corrosion, the establishment of an electrochemical framework for Mg corrosion, illumination of alloying effects, and attempts at corrosion resistant Mg alloys. A discussion drawing from many sources provides an unbiased focus on new achievements, as well as some contentious issues in the field. The electrochemistry of Mg is reviewed in detail, including so-called anodic hydrogen evolution and cathodic activation. This review also covers atmospheric corrosion, and biodegradable Mg alloys. Finally, past and present trends in the field of Mg corrosion are reviewed, identifying knowledge gaps, whilst attempting to also identify future developments and directions.

Contents

* Corresponding author at: Department of Chemistry and Chemical Engineering, Chalmers University of Technology, SE-412 96 Gothenburg, Sweden.
E-mail address: mohsen.esmaily@chalmers.se (M. Esmaily).

http://dx.doi.org/10.1016/j.pmatsci.2017.04.011
0079-6425/