Advancing Lightweight Magnesium Alloys for Sustainable Transportation

Anna Boukalová[1], Jiří Kubásek[1], Klára Hosová[1], Peter Minárik[2], Stanislav Šašek[2]

[1]*University of Chemistry and Technology, Faculty of Chemical Technology, Department of Metals and Corrosion Engineering, Technická 5, 166 28, Praha 6, Dejvice, Czech Republic*

[2]*Charles University, Faculty of Mathematics and Physics, Department of Physics of Materials, Ke Karlovu 5, 121 16 Prague, Czech Republic*

E-mail: boukaloa@vscht.cz

Currently, one of the main concerns in the automotive and aerospace industries is reducing fuel consumption and CO_2 emissions[1-3]. An effective approach is to decrease the weight of vehicles[3], which can be achieved by utilising lightweight materials such as titanium, aluminium and magnesium alloys. Among these, magnesium alloys are particularly noteworthy due to their excellent strength-to-weight ratio, making them the lightest structural material available[4]. To expand the application of magnesium alloys, significant research has focused on enhancing their ignition resistance[5-7]. In this work, magnesium alloy systems based on rare earth (RE) elements and calcium: Mg-4.5Gd-3.4Y-2.6Ca, Mg-2Y-2Gd-1Ca, and Mg-4Ca-1Y (weight %) were prepared through casting and consequent extrusion at 300°C, 350°C, and 400°C temperatures with extrusion ratios of 11 and 25. The microstructure consisted of a solid solution of magnesium, the Mg_2Ca phase and the RE-rich particles. The ignition temperature of both Mg-4.5Gd-3.4Y-2.6Ca and Mg-4Ca-1Y systems exceeded 1100°C, with the Mg-4Ca-1Y alloy achieving this at significantly lower costs for materials preparation. However, the higher contents of Gd and Y positively influenced the mechanical properties of the materials under compression. It is in our future interest to find an effective and cheap way to further enhance the mechanical properties of the Mg-4Ca-1Y alloy while maintaining its remarkable ignition resistance. This work was supported by GACR, project no. 22-22248S, and by Specific university research, project No. A2_FCHT_2024_021.

1. Elsabbagh A, *Ain Shams Engineering Journal*, **2023**, *14*.
2. Zhou B, He L, Zhang S, Wang R, et al., *Journal of Environmental Sciences*, **2023**, *125*, 266-76.
3. Afonso F, Sohst M, Diogo CMA, Rodrigues SS, et al., *Progress in Aerospace Sciences*, **2023**, *137*.
4. Mordike BL, T. E, *Materials Science and Engineering*, **2001**, *A 302*, 37-45.
5. Han D, Zhang J, Huang J, Lian Y, et al., *Journal of Magnesium and Alloys*, **2020**, *8*, 329-44.
6. Tekumalla S, Gupta M, *Materials & Design*, **2017**, *113*, 84-98.
7. Ni J, Jin L, Zeng J, Li J, et al., *Journal of Magnesium and Alloys*, **2023**, *11*, 1-14.