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Editorial

Casting and Forming of Advanced Aluminum Alloys

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1. Introduction and Scope

The automotive and aeronautical industry´s response to the environmental impact provoked by gas emissions and consumer expectations has driven aluminum alloy casting changes in recent years. Light weighting and downsizing have led to the production of smaller and more efficient aluminum alloy casting components with the same or improved mechanical properties, helping fuel economy and gas emissions. Aluminum alloy metal casting is the most cost-effective method to produce shaped and soundness metal components able to answer to clients' requirements. As a result, an increasing trend of using light alloys, namely Al-based alloys, for the production of structural components, has been undergoing major developments. In recent years, we have been confronted with new developments in casting and forming of advanced aluminum alloys, namely in demand for new processing techniques.

The Special Issue *Casting and Forming of Advanced Aluminum Alloys* provides a theoretical and practical understanding of the metallurgic principles in the casting process, advanced melt treatment techniques, and forming process, aiming to enhance the mechanical performance of the aluminum alloys further.

Breakthrough innovations are needed to boost the quality of aluminum alloy research as well as to address the many challenges faced by the need to develop new, advanced techniques in processing enhancing the combination of characteristics such as the low density, the high corrosion resistance, high strength, workability and high electrical and heat conductivity. Contributing to the research into, and innovation of, aluminum alloy application will improve the lives of people. A reflection on the future should be inspired by the goals of sustainability to stretch the boundaries of what is feasible in the function of what is desirable for the people and manufacturing industries. We hope that this Special Issue can deserve the attention of the scientific and industrial community to keep up-to-date with the latest developments in aluminum alloy research.

2. Contributions

Conventional aluminum alloys have reached their limits concerning their mechanical properties. Thus, finding effective and reliable solutions to develop new alloys as well as new technologies for its processing remains a demanding challenge. In this Special Issue of *Metals*, ten articles have been published, covering a wide scope of recent progress and developments regarding some aspects of aluminum alloys, including their processing, microstructure and mechanical properties, corrosion and surface quality. These aspects can be combined into two main groups (1) casting and (2) forming an aluminum alloy.

2.1. Casting Aluminum Alloy

The quality and competitiveness of a casting strongly depend on the quality of the molten alloy and the technology used to produce it. Aluminum alloy casting is not an easy process, since these alloys are prone to dendritic and heterogeneous structures, as well as the absorption of hydrogen during melting. Thus, a specific melt processing operation is required in order to reduce and control

the level of porosity in the microstructure after solidification. Controlling the microstructure of aluminum alloys is of primary importance to achieve high mechanical performance, requiring suitable degassing, modification, and refinement techniques. Conventional casting is a well-established process for the manufacture of a wide variety of aluminum components. Nevertheless, achievable casting performance is limited due to defects that emerge during melt processing and solidification. In recent years, an effort has been made to develop new and reliable techniques to control the microstructure of several engineering alloys, with a particular emphasis on Al-based alloys, to overcome the problems associated with traditional melt techniques.

The effect of traveling magnetic fields (TMFs) on the grain and micro-pore formation in an Al-Cu alloy was studied by Xu et al. [1]. In this study, it was reported that the forced convection induced by TMF break the dendrites, refine the grain size, and promote liquid feeding, leading to a decrease in the volume fraction of the porosity and improved mechanical property. The microstructural evaluation and corrosion resistance of a semisolid Cast A356 alloy were studied by Gebril et al. [2]. For that, a combination of *as-cast* and semisolid casting using a cooling slope processed by equal channel angular pressing (ECAP) was used. Eskin and Wang [3], Kudryashova et al. [4] and Puga et al. [5] applied the ultrasonic vibration to study the effect of ultrasonic melt treatment in the solidified microstructure of aluminum alloys. The role of the roll-separating force in the high-speed twin-roll casting of aluminum alloys was examined by Kim et al. [6]. For that, a traditional twin-roll casting (TRC) process was designed to combine metal casting and hot rolling into a single operation.

2.2. Forming Aluminum Alloy

The forming behavior of aluminum alloys has been assessed through the application of different processes, which include extrusion, stretching, bending and hydroforming.

Ciuffini et al. [7] reported and discussed the relationship between the surface quality and the use of internal liquid nitrogen cooling during the aluminum extrusion. Li et al. [8] focused attention on the mechanisms of cavity nucleation and cavity growth of a 5A70 aluminum alloy during superplastic deformation. The results demonstrated a clear transition from diffusion growth to superplastic diffusion growth and plastic-controlled growth at a cavity radius larger than 1.52 and 13.90 μm. On the other hand, for the same class of aluminum alloy, Li et. al. [9] verified that the superplastic behavior depends on temperatures, strain rates, and precipitated phases during superplastic deformation. Yang et al. [10] outline the findings of the study of the effects of prebending radii on the hardness, tensile strength, yield strength, elongation and HCF performance of the 7075 aluminum alloy after creep age forming.

3. Conclusions and Outlook

The present Special Issue emerges from recent developments in casting and forming, highlighting different aspects of the processing, metallurgical and mechanical behavior of aluminum alloys. All the contributions outline problems and give solutions to achieve further progress in advanced aluminum alloy applications.

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