processes

Editorial

Special Issue "Advances in Innovative Engineering Materials and Processes"

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Successful progress in industrial development requires the use of cost-effective materials and advanced innovative materials with improved properties [1–5]. The physical and chemical properties of most materials can be substantially improved by using the appropriate post-processing procedure, making these materials suitable for technological applications. Process engineering is inextricably linked with the correct understanding and proper application of fundamental natural laws, which allow for the transformation of energy and raw materials into useful products for society. Thus, process research and engineering are focused on the development, optimization and enhancement of chemical, physical and biological processes. Consequently, the development of new processes and the optimization of existing and newly developed post-processing is crucial for both new and large-scale applications since it enables the optimization of the physical, chemical or biological properties of materials [1–5].

The properties of materials are largely related to the material's microstructure, which is affected by its chemical composition, the preparation process conditions and the post-processing conditions [5,6]. Thus, the so-called rapidly quenched materials prepared by the rapid solidification from the melt are among the most promising families of functional materials [5,6]. In this family of functional materials, glassy-like structures can be obtained if the quenching rate achieved during the solidification process is sufficiently high and if the phase diagram of the alloy is appropriate for the preparation of amorphous materials [6]. In this family of functional materials, a glassy-like structure is essentially relevant for the realization of the unique combination of physical properties, such as excellent magnetic softness and good mechanical and anti-corrosive properties [6]. Such a glassy-like structure can be obtained if the quenching rate achieved during the melt quenching is high enough and if the selected alloy phase diagram is suitable for amorphous materials preparation [6]. However, if the quenching rate achieved during the solidification process is not high enough or the phase diagram of the selected alloy does not meet the requirements for amorphous materials preparation, a metastable crystalline material can be obtained [6,7].

Thus, depending on the quenching rate values in a given alloy with an appropriate phase diagram, either amorphous or various metastable phases with a nanocrystalline or microcrystalline structure can be obtained [6,7]. In some cases, the preparation of materials with a mixed microstructure, consisting of nano- or microcrystals embedded in an amorphous matrix, has been reported. In certain alloys, either a supersaturated solid solution or a granular structure can be obtained [6,7].

This Special Issue, "Advances in Innovative Engineering Materials and Processes", provides the most updated information on the latest developments by recognized researchers in the processing of innovative materials to achieve advanced functional properties, making them suitable for various applications. This Special Issue aims to promote research and development in the field of innovative engineering materials, process engineering, the material forming processes, and the optimization of the properties of novel innovating materials (magnetic materials, composite materials, metallic alloys, lubricating media).

The Special Issue is available online at: https://www.mdpi.com/journal/processes/special_issues/Engineering_Materials_Processes (accessed on 30 June 2021).

The contents of this Special Issue cover various theoretical and experimental studies, focusing on the processing of various innovative materials and processes. Despite the interdisciplinary character of the various topics covered in this Special Issue, there is a common thread that connects these areas, such as advanced materials and processes for optimizing their physical properties, which we aim to cover in this issue.

Several of the articles published in this issue deal with magnetic materials and their post-processing, which enables the optimization of their magnetic properties [8–10].

As an example, modern magnetoelectronic device miniaturization has stimulated rapid progress in the development of new micro- and nano-scaled magnetic in the form of nanoparticles, micro or nano- wires and multi-layered thin films and advanced post-processing, improving their physical properties. Studies of such magnetic materials have attracted substantial attention from the broad scientific community [2,4–7,11]. For example, the discovery of the so-called giant magneto-impedance (GMI) effect in soft magnetic materials makes them extremely attractive for a broad range of applications in high-performance sensors, including engineering, industry, biomedicine and others [12]. The highest GMI effect has been realized in soft magnetic materials that have a cylindrical geometry [12]. However, appropriate post-processing (either current annealing or stress-annealing) substantially improves the GMI effect in magnetic wires and hence improves the performance of the magnetic sensors utilizing the GMI effect. Accordingly, several post-processing methods, consisting of either annealing or glass-coated removal in magnetic microwires, allowing the optimization of their soft magnetic properties, are revised in one of the articles of this Special Issue [10].

In another area of research related to the development of advanced magnetic refrigeration technology, the development of new magnetocaloric materials is also of growing interest to scientists. For a higher rate of magnetic cooling, inexpensive and environmentally friendly materials with high cooling efficiency (i.e., a large magnetocaloric effect over a wide temperature range) are required [6–8,11]. To increase the heat transfer rate, it is necessary to increase the surface-to-volume ratio. Therefore, progress in the development of low-dimensional magnetocaloric materials such as ribbons, films or wires has attracted substantial attention from researchers and engineers [11].

Some of the articles published in this issue deal with composite materials: the technological parameter optimization for composites preparation, methods used for the compaction of either technical ceramics or ceramic matrix composites reinforced with carbon nanotubes and the use of ionic polymer–metal composites (IPMCs) for the conversion of ocean energy into electricity [13–15].

The other topic covered in this Special Issue is the processing of metals either by plastic deformation or bending and bending under tension [16,17].

The development of next-generation Ti-based alloys by the addition of various β-stabilizers into a α-Ti matrix of Ti-alloys, allowing the obtainment of Ti-based alloys containing not exclusively α-Ti and β-Ti phases but also some amount of ω-phase and intermetallic compounds, is also covered in this Special Issue [18].

One more topic covered in this issue is the use of an electron accelerator for the controlled aging of the lubricating media used in special vehicles [19].

A comprehensive understanding of the relationship between the processing, structure and properties of the materials produced is critical in all these cases. Consequently, great attention has been paid to systematic theoretical and experimental research with the general goal of expanding our current knowledge on the material properties' origins in relation to nano- and micro-structure and, accordingly, to the prediction of new, unusual macroscopic properties. These features are the common theme of all articles in this Special Issue.

All of the articles in this volume were subjected to peer-review by international reviewers with recognized scientific credentials. The main selection criteria for the papers published in this Special Issue were their quality and their relevance to the topics.

We wish to thank all of the authors who have contributed to this volume and the reviewers for their support of this Special Issue of *Processes*.

At last, we hope that the contents of this Special Issue will prove to be a useful and unique resource for many researchers and practitioners involved in different areas of Material science related to developing and applying new technologies and processes in the field of smart engineering materials and innovative engineering materials. Therefore, we believe that this issue will bring interesting information to readers and will be useful for researchers involved in this scientific research area.

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