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Editorial: Hexagonal Close-Packed Metals and Alloys: Processing, Microstructure and Properties

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Editorial on the Research Topic

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In comparison with face-centered cubic (FCC) and body-centered cubic (BCC) metals and alloys, hexagonal close-packed (HCP) metals and alloys show distinct characteristics, such as atomic site occupation, anisotropic microstructure, and fewer slip systems, owing to their HCP lattice structure. Therefore, HCP metals and alloys have distinguished processing, microstructure, and properties. Several types of HCP metals and alloys, involving titanium, zirconium, magnesium, and so on, are extensively used in a variety of industrial and military sectors. Up to date, an increased requirement is still needed to improve the understanding of the relationships among processing, microstructures, and the resultant properties of HCP metals and alloys. In the meantime, surface modification may be conducted on the HCP metals and alloys to obtain better surface properties. However, many challenges are still open for the surface modification of HCP metals and alloys. In the contents of this topic, many endeavors are made to highlight the recent advances related to the processing methods (including surface modification), microstructures, and properties of HCP metals and alloys.

In the aspects of titanium alloys, Cheng et al. developed a meta-stable β-type Ti-25Nb-3Zr-2Sn-3Mo (TLM) alloy and investigated the room-temperature deformation and superelastic behavior of TLM alloy under different processing conditions (10.3389/fmats.2020.00114). The results showed that the typical double yielding phenomena of TLM alloys are presented during the deformation at room temperature and the stress-induced martensite phase and deformation twins are simultaneously generated in the microstructures of TLM alloys during the deformation. Such alloys exhibit a certain superelastic effect due to the reverse transformation between the stress-induced martensite α'' phases and β parent phases during the cyclic loading-unloading at room temperature. Cheng et al. also investigated the effect of cold swaging deformation on the microstructures and mechanical properties of TLM alloys (10.3389/fmats.2020.00228). With the increment in the reduction of swaging deformation, stress-induced martensite transformation takes place, resulting in the production of α'' phase. Meanwhile, the strength of the processed alloy is gradually enhanced associated with the decrease in the elastic modulus. Fan et al. investigated the microstructures, mechanical properties, and texture characteristics of marine titanium alloy Ti6321 sheets with four different initial microstructures (10.3389/fmats.2020.00110). The anisotropic characteristics of the tensile deformed Ti6321 alloy sheet at room temperature are mainly attributed to the difference in the Schmid factors in the transverse direction and the rolling direction of specimens.

In the aspects of magnesium alloys, An et al. investigated the single-point incremental forming (SPIF) process for rapid prototype manufacturing and small-scale productions of magnesium alloy sheets (10.3389/fmats.2020.00151). The formability of AZ31 magnesium alloy sheet using warm SPIF is improved with the increase in the number of forming stage, forming temperature, and tool diameter but reduced with the increase in the feed rate and interlayer spacing. The suitable forming temperature for AZ31 magnesium alloy sheet is about 250°C. Yu et al. investigated the effect of Ti addition on microstructure, texture, and mechanical property of as-extruded Mg-Sn alloy (10.3389/fmats.2020.00149). The addition of Ti has an apparent effect on intensifying the basal texture where the basal slip can not be easily activated during tensile test. As a result, the produced alloy shows excellent mechanical properties where yield strength and elongation are 200 MPa and 30.2%, respectively.

In the aspects of surface modification of HCP metals and alloys, Zang et al. used nano-ZrO_2 as the reinforcements and friction stir process as surface modification method to fabricate the composite surfaces of AZ31 magnesium alloys (10.3389/fmats.2020.00278). The AZ31/2.14 vol% ZrO_2, AZ31/4.29 vol% ZrO_2, and AZ31/6.43 vol% ZrO_2 composites are designed and processed with three multi-passes and high rotation speeds. The hardness and tensile properties are enhanced after three cumulative friction stir processing passes. The tensile properties and hardness of the AZ31/ZrO_2 composites increased with the increase of volume fraction of the ZrO_2 particles from 2.14 to 6.43 vol%. Wang et al. fabricated the micro-arc oxidation (MAO) coating on ZK60 magnesium alloys using two-step current decreasing mode in a dual electrolyte system for potential biomedical application. The fabricated coating exhibits a smooth and compact surface, and has improved hardness, larger thickness, smaller roughness, and uneven distribution of holes. Such positive characteristics result in improved corrosion resistance of MAO coatings. The coating produced under the two-steps current mode of “1.2–0.6A” shows a smaller corrosion rate of 0.1559 $g/m^2 \cdot h$ compared with the one produced under the following mode. Meanwhile, Wang et al. used another method to fabricate the corrosion-resistant coating on ZK60 magnesium alloys by combining micro-arc oxidation and electrophoresis deposition. A dense hydroxyapatite layer with a thickness of 5 mm is successfully prepared on the MAO coating. Therefore, the surface-modified ZK60 magnesium alloys with good corrosion resistance and good biocompatibility are obtained.

The contributions of the above work were summarized as follows: the design method and processing method of titanium alloys (Cheng et al. and Fan et al.); the processing of magnesium alloys and their resultant properties (An et al. and Yu et al.); the surface modification methods of magnesium alloys, including friction stir process, micro-arc oxidation and electrophoresis deposition (Zang et al. and Wang et al.). This research topic focused on the processing procedures, microstructures, and properties of HCP metals and alloys, and all the results presented would promote the development of HCP metals and alloys.

AUTHOR CONTRIBUTIONS

L-YC, LC, and L-CZ analyzed the topic submissions and co-wrote the paper.

Conflict of Interest: The authors declare that the research was conducted in the absence of any commercial or financial relationships that could be construed as a potential conflict of interest.