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Editorial

Improvement and Application of Zirconium Alloys

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1. Introduction and Scope

Zirconium (Zr) alloys have attracted special attention because of their application in various fields such as nuclear cladding materials, biomedical implant materials and shape memory materials. This Special Issue mainly aims to address the corrosion and the surface modification of Zr alloys, pellet-cladding interaction and irradiation-induced damage. It also examines Zr alloys as biomedical materials and shape memory materials.

2. Contributions

Corrosion resistance and mechanical properties are two important factors in designing nuclear cladding materials. The corrosion resistance and mechanical strength of Zr alloys, to a large extent, depend on alloying elements. The paper by Zhang et al. [1] provides an insight into the influence of Sn element on the properties of Zr-based alloy. Based on this work, a new low-Sn Zr alloy series of Zr-0.25Sn-0.36Fe-0.11Cr-xNb was developed. This type of alloy shows an excellent corrosion resistance and high strength, and might be a candidate for use in nuclear reactors. The corrosion resistance of Zr alloys is also related to the surface properties of alloys. The paper by Obrosov et al. [2] used plasma immersion ion implantation to modify the surface properties of Zr–1Nb alloy, and studies the influence of Ti implantation on surface morphology, oxidation rate, and phase structure of Zr–1Nb alloy. Pellet-cladding interaction can lead to the accelerated failure of fuel channels systems in nuclear reactors. The paper by Zhou and Zhou [3] used the CityU Advanced Multiphysics Nuclear Fuels Performance with User-defined Simulations (CAMPUS) code to study the thermophysical performance and solid mechanics behavior of UO_2-36.4 vol % BeO fuel pellets cladded with Zircaloy, SiC, and FeCrAl, and Zircaloy cladding materials coated with SiC and FeCrAl, and compared the mechanical interactions of fuel and cladding materials. The stability of materials under high-energy irradiation is crucially important for the safety of nuclear reactors. The paper by Dong et al. [4] studied the precipitate stability of Zr-2.5Nb-0.5Cu alloy under heavy ion irradiation, the effects of the surrounding microstructure on the precipitate stability, and the irradiation-induced alloying element redistribution.

Zr alloys can also be used as biomedical materials and have an important application in magnetic resonance imaging due to its relatively small magnetic susceptibility. The paper by Ashida et al. [5] studied the influence of different thermomechanical process on the mechanical properties and magnetic susceptibility of the Zr–1Mo alloy. The paper by Sun et al. [6] used the powder-bed fusion process to prepare a low-magnetic Zr–1Mo alloy, and studied the effects of the process parameters on surface morphology, pore distribution, and hardness of Zr-1Mo alloys.

In addition, equiatomic Zr–Pd alloy can be used as shape memory materials with high transformation temperature. The paper by Matsuda et al. [7] reconstructed the phase diagram of a near equiatomic Zr–Pd binary system and determined the exact eutectoid and peritectoid temperatures.

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