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Comparative Study of Microstructure and Mechanical Properties of Ti-doped and Zr-doped CoCrFeMoNi systems

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ABSTRACT

Introduction

Research on high-entropy alloys (HEAs) has been increasing the number of publications in recent years, greatly expanding chemical composition of these modern alloys, that may produce many phases and intermetallic compounds, resulting in complex microstructure. Among these, the CoCrFeMoNi has shown a ductile FCC matrix with intermetallic compound precipitation, which provide good mechanical properties. The incorporation of additional elements into HEAs tailor their properties for specific applications. This study aims to investigate the influence on mechanical properties of CoCrFeMoNi alloy, when doped with Ti, compared to Zr-doping.

Experimental

Raw materials with high purity levels of at least 99.7% for Co, Cr, Fe, Mo, Ni, Ti and Zr were utilized. Doping on the CoCrFeMoNi system was carried out separately with Zr in a proportion of 0.71% for the Zr-doped HEA, and a proportion of 0.28% titanium for the Ti-doped HEA. The obtained alloys were subjected to at least 6 rounds of flipping and re-melting using a MRF ABJ 900 vacuum arc remelting (Allenstown, Merrimack, NH 03275, USA) under an inert Argon atmosphere to achieve adequate homogeneity. For the composition study, energy dispersive X-ray analysis was applied using a Fei XL30 ESEM (MTM, Leuven, Belgium) scanning electron microscope outfitted with an EDAX Sapphire detector. For phase characterization, X-ray diffraction data were measured with a Bruker D8 ADVANCE diffractometer (Bruker Corp. Billerica, MA, USA). And microstructure observation was obtained from Hitachi TM3030 Scanning Electron Microscope, with and EDX spectrometer (Hitachi Hich-Tech Science Corporation, Tokyo, Japan).

Finally, to determine the microhardness of the samples, indentation test were conducted using Shimadzu HMV 2T equipment (Shimadzu,Kyoto,Japan), and for the modulus of elasticity, a three-point bending test was performed, through a BOSE Corporation Electroforce 3100 machine (Bose Corporation, Eden Prairie, MN, USA), applying a maximum load of 22N and following standards from ISO 7438:2020.

Results and discussions

Representative SEM images of the CoCrFeMoNi alloy and the two doped alloys show a compact microstructure, with dendritic formation. Both Ti and Zr additions produced grain refinement. A semi-quantitative analysis on the micro-areas revealed chemical composition in