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Mechanical Alloying Synthesis and Physical Properties Characterization of Equiatomic High Entropy CrMnFeCoMo Alloy

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Introduction

High-Entropy Alloys (HEAs) represent a shift in the conventional design of alloys, characterized by high configurational entropy in a multi-elemental substitutional solid solution in typically equiatomic proportions with simple structures. The most studied alloy is the pioneering CrMnFeCoNi, recognized for its potentially applications in refractory, corrosion-resistant, magnetic, biomedical and electronic materials. This study focuses on the and structural, mechanical, thermal, morphological and electrochemical characterization of a Cantor alloy variant, substituting Ni with Mo (the CrMnFeCoMo alloy) chasing for better pitting corrosion resistence. The synthesis involved high-energy mechanical alloying and consolidation via arc melting processes.

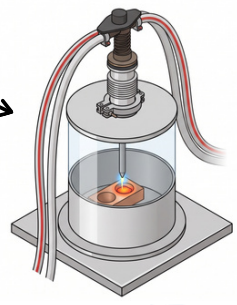
Methodology



High-Energy Mechanical Alloying



High-Entropy Alloy (powder form)



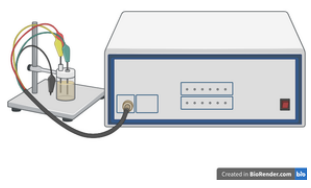
Arc Melting



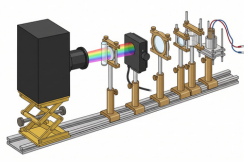








Consolidated Alloy Characterization (XRD, Vickers Microhardness, PP and EIS)



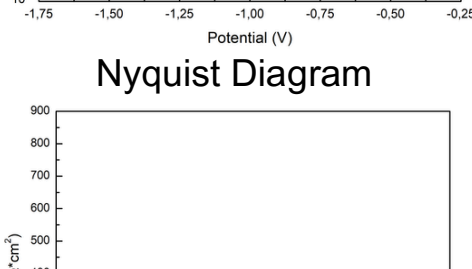


Powder Characterization (XRD, SEM, PAS and DSC)

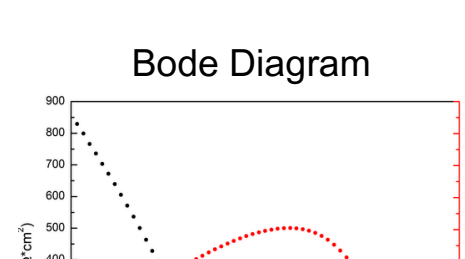
Results and Discussion

XRD

Mechanical Alloying Sample



As Cast Sample

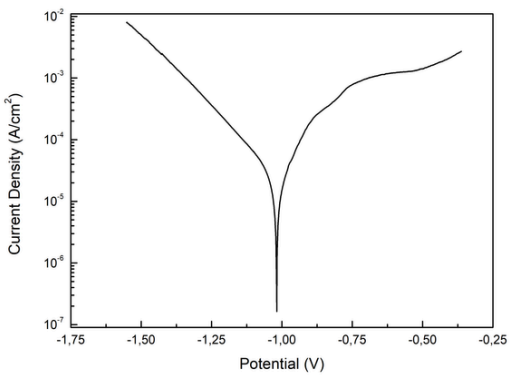


Thermal and Mechanical Properties

Property	Value	Unit
Thermal Diffusivity	466	mm²/s
Specific Heat	424	J/kg.K
Thermal Conductivity	16.33	W/m.K
Vickers Microhardness	724	HV

Electrochemical Properties

Tafel Diagram



Ecorr	icorr	Epit
-1.01 V	2,73x10-6 A/cm²	-

Nyquist Diagram

Bode Diagram

Conclusions

- Phase Stability: The CrMnFeCoMo alloy forms a dual-phase substitutional solid solution with two BCC phases (lattice parameters 3,14 Å and 2,90 Å) and partially segregates with intermetallic precipitation after melting;
- Thermal Analysis: The alloy exhibits reduced thermal diffusivity compared to the theoretical reference (28,08 mm²/s) and lower than that of the Cantor alloy (7,23 mm²/s). The cp is also reduced compared to the
- Cantor alloy (536 J/m.K) and the conductivity behavior results from diffusional mechanisms and specific heat;
- Vickers Microhardness: The alloy exhibits high microhardness with widely scattered values due to intermetallic compounds distributed across the alloy surface;
- Electrochemical Analysis: The alloy exhibits difficulty in forming a passive film on its surface compared to the Cantor alloy.

References

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- PRADHAN, P., SHADANGI, Y., SHIVAM, V., MUKHOPADHYAY, N. K. Powder metallurgical processing of CrMnFeCoMo high entropy alloy: Phase evolution, microstructure, thermal stability and mechanical properties. Journal of Alloys and Compounds, v. 935, part 2, 168002-168013, 2023. DOI: doi.org/10.1016/j.jallcom.2022.168002