

Optimal mechanical alloying and spark plasma sintering technique to obtain nanocrystallinity, minimal contamination and enhanced oxidation behaviour in AlCoCrFeNi high entropy alloys

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The effect of the phase constitution of BCC/B2, FCC, Cr_7C_3 and their microstructural attributes are conspicuous on the hardness properties of AlCoCrFeNi HEAs [1]. The correlation of unsolicited C and O contaminant with process parameters (milling duration/rpm) and process control agent (PCA) categorically established that contamination increases with duration of mechanical alloying (MA) [2]. It is imperative to devise an optimised MA procedure (patent applied under Intellectual Property of India) followed by spark plasma sintering (SPS) leading to reduced contaminant accrual resulting into enhanced hardness and oxidation resistance [3, 4]. Fig. 1 vividly elucidates that AlCoCrFeNi equiatomic HEA can achieve complete solid solution with an optimal milling duration (3-5 h), lower rpm, and toluene PCA (Fig.1(a) XRD). This can be attributed to the high enthalpy of mixing of Al with all other constituent elements. Evidently, the Ni-Al rich BCC phase as well as the Fe-Co rich FCC phase is formed in just 5 h of MA (Fig.1(a) SEM). Moreover, nanocrystalline grain size (Fig.1(b)) with inherent oxide nano-dispersoids is certainly achieved in the 5 h as-milled powder (Fig.1(c)). A brief sintering procedure (SPS) prevents grain growth and leads to a systematic variation of BCC/B2, FCC, and Cr_7C_3 phase fraction (Fig.1(d)) resulting into a bimodal grain size distribution (Fig.1(e)), enhanced microhardness, and oxidation resistance (Fig.1(f)).

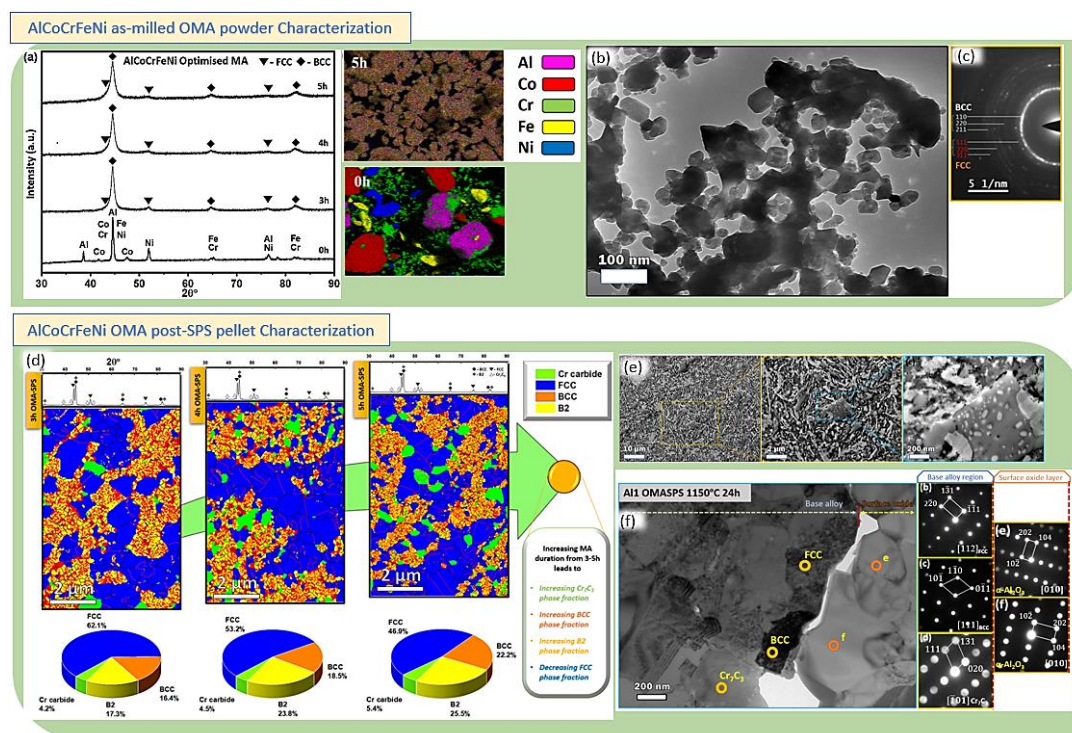


Figure 1: Detailed characterization of Optimal MA-SPS of AlCoCrFeNi leading to minimal contaminant accrual with enhanced hardness, oxidation resistance, and nanocrystallinity.

1. Bhattacharya, R., et al., Journal of Materials Research, 2022. **37**(4): p. 959-975.
2. Jayasree, R., et al., Materials Letters, 2021. **292**.
3. Garg, M., et al., ACS Omega, 2022. **7**(15): p. 12589-12600.
4. Anupam, A., et al., Corrosion Science, 2021. **184**.