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Paper Title: Enhancing the strength-ductility synergy of dual-phase Al0.3CoCrFeNiTi0.3 high-entropy alloys through the regulation of B2 phase content
Content :

In this study, $Al_{0.3}CoCrFeNiTi_{0.3}$ high-entropy alloys (HEAs) with different phase contents and microstructures were prepared through cold rolling and recrystallization annealing. This method achieved a synergistic combination of strength and ductility, with the CR1000-1 HEA attaining an ultimate tensile strength of 1175 MPa and a uniform elongation of 21.5 %. In $Al_{0.3}CoCrFeNiTi_{0.3}$, there exist two distinct phase morphologies: dispersed structure and clustered structure. Using in-situ high-resolution digital image correlation at the microscale, it was observed that local strain in the dispersed structure tends to concentrate along the phase boundaries when a small strain is applied. As the applied strain increases, strain rapidly concentrates in the FCC phase and subsequently in the B2 phase. For the clustered structure, the strain initially concentrates rapidly within the B2 phase and then gradually diffuses into the FCC phase. The low degree of inhomogeneity of the dispersed structure reduces the likelihood of stress concentration and the risk of damage initiation. Furthermore, we observed the synergistic strain hardening effect produced by various deformation mechanisms, such as dislocation pile-ups, dislocation networks, interacting stacking faults, and deformation twins. This study provides valuable insights for the fabrication of dual-phase HEAs with enhanced strength-ductility synergy, applicable to a wide range of engineering applications.

Mechanical properties

Fig. 5(a) illustrates the tensile engineering stress-strain curves for the four samples subjected to different treatments. The CR1000-1 sample demonstrates a yield strength (σ_y = 715 MPa) coupled with excellent uniform elongation (ε_u = 21.5 %). Conversely, the CR1100-1 sample achieves the highest uniform elongation (εu = 33.3 %). The CR900-5 sample exhibits a yield strength of 606 MPa and an ultimate tensile strength of 1133 MPa. Remarkably, the CR950-4 sample, despite having the smallest grain size, has the lowest yield strength at 470 MPa. Among all samples, the CR1000-1 displays the most pronounced strain hardening effect, with its ultimate tensile strength increasing by 460 MPa from its yield strength to reach 1175 MPa. Fig. 5(b) presents the true stress-strain curves alongside the strain hardening rate versus true strain curves for the four samples. The result reveal that the CR900-5 sample exhibits a high initial strain hardening rate, which diminishes rapidly as the material approaches fracture. The CR1000-1 sample shows the highest strain hardening rate, maintaining a $\Theta > \sigma_{true}$ up to 20 % true strain. Fig. 5(c) compares the tensile properties of the $Al_{0.3}CoCrFeNiTi_{0.3}$ HEA samples with those reported in existing literature. Relative to these reference alloys, the CR900-5 sample shows lower uniform elongation, while the CR950-4 and CR1100-1 samples offer moderate strength and ductility. Notably, the CR1000-1 sample exhibits the optimal balance of strength and ductility among the samples tested.