Paragraph Ran in the Queries

Paper Title: The effect of cooling rate on the precipitation behavior and fracture toughness of the η phase in LDED CoCrFeNiTi high-entropy alloy

Content :

Microhardness

Hardness tests were conducted to assess the changes in mechanical properties resulting from the evolution of the η phase in the HEA. Fig. 6 illustrates the microhardness distribution of CoCrFeNiTi HEA samples at various cooling rates. The results indicated that aging treatment notably increased the microhardness of the CoCrFeNiTi HEA samples. The average microhardness of the LDED samples was ~660 HV. Subsequently, the average microhardness of WC, AC, and FC samples was ~744 HV, ~860 HV, and ~807 HV, respectively. Notably, the AC sample exhibited the highest microhardness among the tested samples, positioning it as an outstanding candidate material for wear resistance. Furthermore, the impact of cooling rate on the microhardness of CoCrFeNiTi HEA was indeed significant.

Fracture toughness

The Palmqvist method is widely used to evaluate the fracture toughness of highly brittle ceramic materials and has recently been successfully applied to high-hardness HEAs [7,32,33]. Specifically, the as-deposited CoCrFeNiTi HEA exhibited a microhardness of up to ~660 HV, which increased to ~860 HV in aged AC sample. This high hardness, combined with a certain degree of brittleness, makes it suitable for evaluating fracture toughness using the indentation method. To induce cracks effectively, a large load of 50 N was applied to ensure sufficient stress on the samples, facilitating crack formation and subsequent analysis. Fig. 7(a) shows the crack length and fracture toughness of CoCrFeNiTi HEA at different cooling rates. The average lengths of crack propagation for WC, AC, and FC samples were ~8.7, ~3.8, and ~10.7 μm, respectively. Correspondingly, the fracture toughness (K_{IC}) values for WC, AC, and FC samples were 7.0, 7.5, and 6.9 MPa $m_{0.5}$, respectively. The indentation morphologies of WC, AC, and FC samples are displayed in Fig. 7(b–d). In comparison with AC and FC samples, the AC samples exhibited the fewest cracks and the shortest propagation length, indicating superior fracture toughness. The differences in fracture toughness among these samples were directly related to the evolution of the η phase.