Structure and Mechanical Properties of Splat-Quenched Al-Co-Cr-Fe-Ni-V Alloys Films

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Most conventional alloys traditionally have been based on one solvent element to which various solute atoms are added for improving specific properties. In recent years, one kind of new alloys, high-entropy alloys (HEA) with multiple principal elements, has received more and more attentions due to its unique structure and excellent properties in hardness and wear resistance, exceptional high-temperature strength, good structural stability, radiation and corrosion resistance [1]. Each principal element in HEA should have a concentration between 5 and 35 at.%. Because of high mixing entropy of HEAs (12-19 J/(K·mol)), they usually consists of some simple solid solutions, instead of complex phases or inter-metallic compounds. Structure and mechanical properties (microhardness) of splat-quenched films (cooling rate~10^6 K·s^{-1}) of HEAs of Al-Co-Cr-Fe-Ni-V system are investigated in this paper.

The XRD patterns were used to determine the phase composition, lattice parameters, and the parameters of the fine structure (size of coherent scattering areas) and microstresses. The density of dislocations ρ was estimated based on the profile of the first diffraction maximum. The results obtained are given in Table. XRD analysis allowed us to establish what splat-quenched films of $Al_xCoCrFe_yNiV$ HEAs have single-phase body-centered cubic (BCC) structure. The lattice parameters shows that the solid solution are based on chromium as the element with the highest melting point (the lattice parameter of Cr a= 0.2884nm). High microhardness values of alloys can be explained by the presence of the dissimilar atoms of elements with different size, electronic structure and thermodynamic properties in the crystal lattice. This leads to significant distortion ($\Delta a/a$) of crystal lattice. Consequently the hardness of $Al_xCoCrFe_yNiV$ alloys films has been increased.

Table.

Phase composition, coherent scattering areas (L), degree of crystall lattice distortions (Δa/a), microhardness (H_μ) and dislocation density (ρ) in films

Alloy	Phase composition	L, nm	$\Delta a/a$	H_μ, MPa	ρ, cm^{-2}
AlCoCrFeNiV	BCC (a=0.2883 nm)	33±2	$2.0\cdot10^{-3}$	6600±300	$1.55\cdot10^{12}$
$AlCoCrFe_2NiV$	BCC (a=0.2880 nm)	24±2	$2.8\cdot10^{-3}$	6200±200	$6.30\cdot10^{11}$
$Al_2CoCrFeNiV$	BCC (a=0.2889 nm)	34±2	$1.3\cdot10^{-3}$	7500±300	$4.60\cdot10^{11}$
$Al_2CoCrFe_2NiV$	BCC (a=0.2882 nm)	33±2	$1.7\cdot10^{-3}$	5600±200	$4.52\cdot10^{12}$

1. Murty B.S., Yeh J.W., Ranganathan S. High-Entropy Alloys.–London:Butterworth-Heinemann, 2014.–218p.