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Abstract

Design and Characterization of $Cr_{29.7}Co_{29.7}Ni_{35.4}Al_{4.0}Ti_{1.2}$ Precipitation Hardened High Entropy Alloy †

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In 2004 a new class of metallic alloys, called high entropy alloys (HEA), was introduced in the literature. The main concept behind these alloys is that they have multiple main elements instead of only one or two. Therefore, they can exist under a vast compositional landscape, most of which is yet to be explored. In the early studies on HEAs, a great effort was made on searching for single-phase alloys with optimized properties, mainly those with a face-centered cubic structure (FCC). Recently, in the so-called "second generation" of HEAs, research focus has been broadened to multi-phase alloys. In particular, those alloys with FCC matrix plus $L1_2$ precipitates or BCC matrix with B2 precipitates to compete with traditional superalloys. In the present work, CALPHAD method (via Pandat® software) was used to aid the design of a new precipitation hardened, namely $Cr_{29.7}Co_{29.7}Ni_{35.4}Al_{4.0}Ti_{1.2}$ (a.t %), with a FCC matrix and $L1_2$ precipitates. The alloy was produced, solution-treat, cold-rolled and annealed, the alloy was then cut into different pieces and aged at 850 °C for different times. The microstructure was composed of spherical precipitates distributed uniformly in the FCC matrix. The characterization of the microstructure showed that thermodynamic calculation was accurate. The improvement in mechanical properties caused by introducing the ordered precipitates, analyzed through microhardness test, showed a promising mechanical behavior of the new designed alloy.