EFFECT OF RARE EARTH MISCHMETAL ADDITIONS ON THE MICROSTRUCTURAL AND MECHANICAL PERFORMANCE OF INCONEL 718 SUPERALLOY FABRICATED BY POWDER METALLURGY

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The Superalloy Inconel 718 (IN-718) has excellent mechanical performance and high oxidation resistance; the main uses are in parts aerospace engines and the petrochemical industry at relatively elevated temperatures. Recent research has focused on determining the effects of adding rare earth elements (REE) mixtures in superalloys to improve the microstructural and mechanical characteristics. For this reason, this investigation is focused on understanding the correlation between the REE mischmetal additions, hot isostatic pressure (HIP) sintering, and heat treatments in the microstructural and mechanical properties in In-718.

The In-718 with and without REE contents were obtained by mechanical alloying in a High-energy mill Spex. Commercial In-718 and REE mischmetal with a purity of 99 % and composed of Ce:La:Nd:Pr 50-55:30-35:5-10:5-10 wt. % were used to fabricate the reference sample and the alloys with contents of 0.1, 0.2 and 0.3 wt. % of REE. The sintering process was made through HIP and conventional sintering (CS). The first was carried out at 1200 ºC for 4 h (120 MPa) in an argon gas atmosphere. The second was carried out in a tubular electric oven using vacuum-sealed quartz ampoules at the same temperatures and times as the HIP. The alloys were solubilized to 980 °C for 1 h and quenched in water at room temperature. Posteriorly, a standard two-step aging treatment was performed. The microstructural characterization of the samples was performed in a Bruker x-ray diffractometer and FE-SEM JSM-7401F and HITACHI 7700 scanning electron microscopes. Mechanical properties were evaluated in a LECO LM300 AT microhardness tester.

The microstructural analysis showed that the REE additions, heat treatments, and HIP sintering favored the formation of smaller grain sizes with a microstructure composed of the γ matrix phase, oxides and carbides. Furthermore, the REE promoted new nucleation sites that generated the formation of grain boundaries. In both sintering routes, the reference sample showed a higher crystallite size after aged treatment concerning the alloys with additions of REE due to REE suppressing the growth of crystallites and grains. The hardness evaluation showed essential increments in the alloys with REE content.

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