

The Investigation of Niobium Addition on Mechanical Properties of Al11Si alloy

Authors : Kerem Can Dizdar, Semih Ateş, Ozan Güler, Gökhan Basman, Derya Dışpınar, Cevat Fahir Arısoy

Abstract : Grain refinement and obtaining homogeneous microstructure is the key parameter in casting of aluminum alloys. Ti has been traditionally used as grain refiner, however, inconsistency and heterogeneous dendrite arms, as well as fading efficiency, have been the drawbacks of Ti. Alternatively, Nb (Niobium) has gained attention. In this work, the effect of Nb was investigated in case of both as cast and T6 heat treated conditions. Different ratios of Nb (0.0, 0.03, 0.05, 0.07, 0.1 weight%) were added to AlSi11 alloy, mechanical properties were examined statistically, and relationship was established between microstructure and mechanical properties by examining the grain size and dendrite characteristics before and after heat treatment. Results indicate that in the case of as cast state; with the increasing addition of Nb has no significant effect on yield strength, however, it increases the tensile strength and elongation starting with 0.05wt% ratio, and it remains constant up to 0.1wt%. For the heat-treated condition; Nb addition provides increment at yield strength and tensile strength up to 0.05wt%, but it leads to decrement from 0.05 to 0.1wt%. The opposite is valid for the elongation; It decreases in between 0-0.05wt% then rises in range of 0.05-0.1wt%. Highest yield strength and ultimate tensile strength were found T6 heat treated 0.05wt% Nb addition. 0.05wt% was found as critical Nb addition ratio for mechanical properties of Al-11Si alloys. Grain refinement and obtaining homogeneous microstructure is the key parameter in casting of aluminum alloys. Ti has been traditionally used as grain refiner, however, inconsistency and heterogeneous dendrite arms, as well as fading efficiency, have been the drawbacks of Ti. Alternatively, Nb (Niobium) has gained attention. In this work, the effect of Nb was investigated in case of both as cast and T6 heat treated conditions. Different ratios of Nb (0.0, 0.03, 0.05, 0.07, 0.1 weight%) were added to AlSi11 alloy, mechanical properties were examined statistically, and relationship was established between microstructure and mechanical properties by examining the grain size and dendrite characteristics before and after heat treatment. Results indicate that in the case of as cast state; with the increasing addition of Nb has no significant effect on yield strength, however, it increases the tensile strength and elongation starting with 0.05wt% ratio, and it remains constant up to 0.1wt%. For the heat-treated condition; Nb addition provides increment at yield strength and tensile strength up to 0.05wt%, but it leads to decrement from 0.05 to 0.1wt%. The opposite is valid for the elongation; It decreases in between 0-0.05wt% then rises in range of 0.05-0.1wt%. Highest yield strength and ultimate tensile strength were found T6 heat treated 0.05wt% Nb addition. 0.05wt% was found as critical Nb addition ratio for mechanical properties of Al-11Si alloys.

Keywords : al-si alloy, grain refinement, heat treatment, mechanical properties, microstructure, niobium, sand casting

Conference Title : ICAMQI 2022 : International Conference on Aluminum Metallurgy and Quality Issues

Conference Location : Toronto, Canada

Conference Dates : September 20-21, 2022