Microstructure of the Al-9wt%Si Alloy with Different Fe Contents

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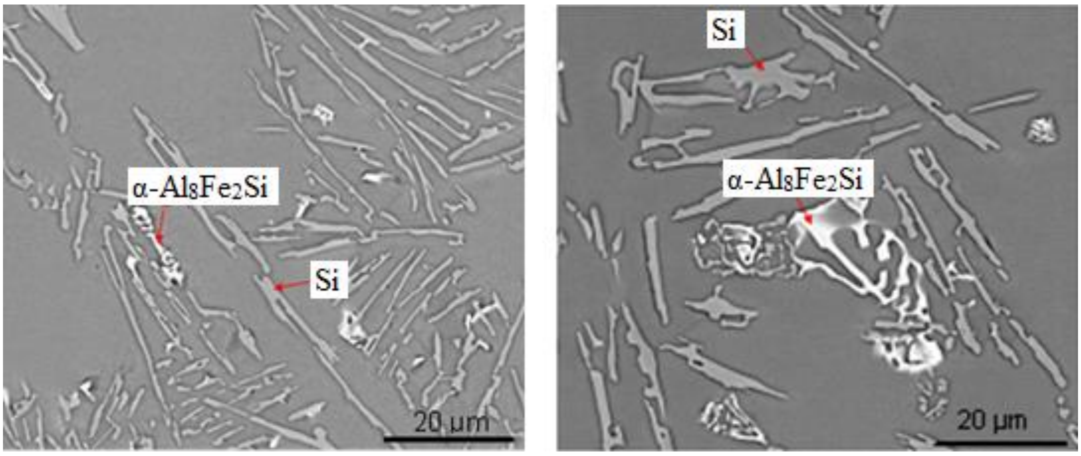
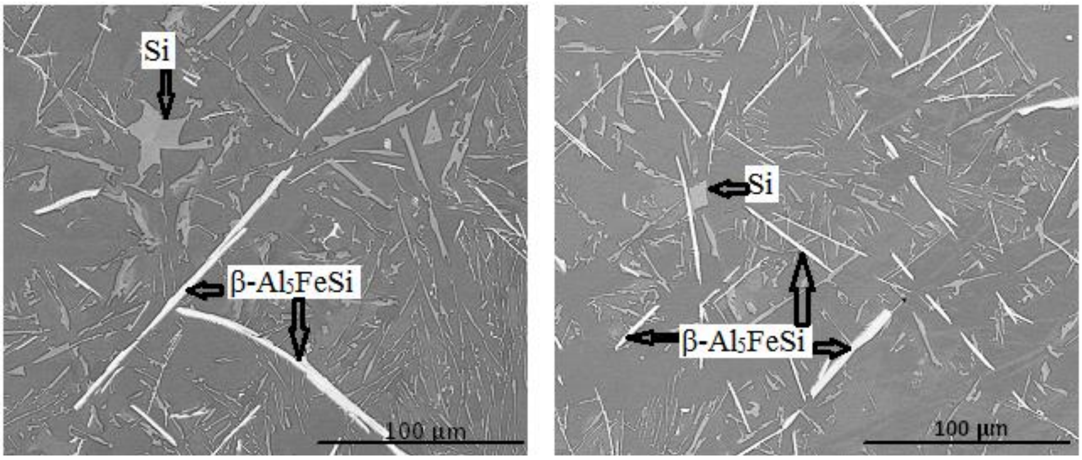
The Al–Si is the most used cast Al alloy due to their wide application in commercial components. This element strongly reduces the fluidity and the overall mechanical properties through the formation of brittle intermetallic phases. The most common intermetallic is the β-Al_5FeSi phase, which generally has a complex plate-like morphology that interrupts the continuity of the matrix, becoming preferential places for crack nucleation and growing. The α-Al_8Fe_2Si is another intermetallic phase which presents a Chinese script-like morphology. Generally, the α-Al_8Fe_2Si is less detrimental than β-Al_5FeSi phase for the mechanical properties of the alloy owing to its compact morphology. Based on this, the aim of this work is to study the microstructure of the Al-9wt%Si alloy with Fe contents between 0.1 to 1.2 wt%. The chill casting process was chosen due to the higher supercooling of the material during solidification when compared with the sand casting. The material was melted in an induction furnace utilizing a crucible with 30 kg of capacity. The pouring temperature was 760°C. The micrographs were obtained with the aid of a PHILIPS EDAX XL 30 SEM. Figure 1(A) shows the microstructure of the Al-9wt%Si alloy with 0.1 wt% of Fe. It can be seen the Al dendrites and the distribution of the eutectic Si particles with needle shape morphology in the interdendritic regions. Despite the low amount of Fe present in this alloy and the high cooling rate of the chill casting process, it was possible to note the presence of the α-Al_8Fe_2Si intermetallic phase with Chinese script-like morphology near the eutectic Si particles. Figure 1(B) shows the microstructure of the Al-9wt%Si alloy with 0.4 wt% of Fe. It was possible to note the presence of α-Al_8Fe_2Si particles with higher amount and size than the alloy with 0.1 wt% of Fe. Figure 2(A) shows the microstructure of the Al-9wt%Si alloy with 0.8 wt% of Fe. It can be seen the Si and β-Al_5FeSi particles. Figure 2(B) shows the microstructure of the Al-9wt%Si alloy with 1.2 wt% of Fe. It presents the eutectic Si particles between the arms of Al dendrites and the thick β-Al_5FeSi particles formed near the eutectic regions. The high amount and size of β-Al_5FeSi particles occurs due to high amount of Fe content. Note that the particles formed by the primary eutectic reaction are bigger that those formed by the secondary eutectic reaction. The sample with 1.2 wt% of Fe presented higher amount of β-Al_5FeSi particles than the alloy with 0.8 wt% of Fe and, consequently, higher amount of micropores. Figure 3(A) shows the micropores limited by the β-Al_5FeSi particles in the microstructure of the Al-9wt%Si alloy with 0.8 wt% of Fe. This micrograph also shows how β-Al_5FeSi platelets constitute potential barriers for liquid metal feeding in a casting region subjected to shrinkage. The amount of β-Al_5FeSi phase and, consequently, the amount of micropores is proportional to the Fe content. Figure 3(B) shows the β-Al_5FeSi particles formed by the secondary eutectic reaction $L \rightarrow \alpha + Si +$ β-Al_5FeSi inside a micropore of the Al-9wt%Si alloy with 0.8 wt% of Fe. These particles probably appeared when the vacancies were partially filled with the eutectic liquid and, after the solidification, nucleating and growing along the dendrite ramifications.



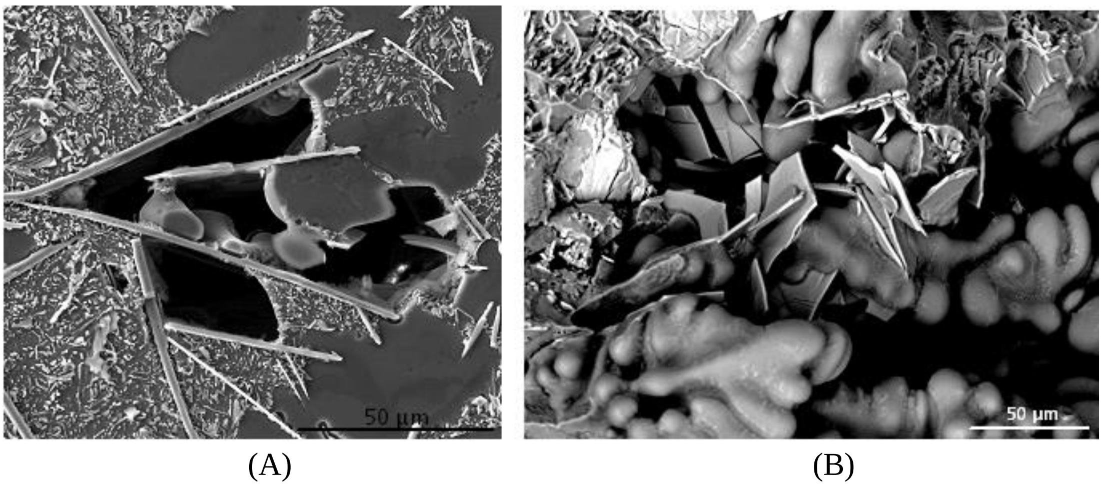
(A) (B)

Figure 1: SEM micrographs of Al-9wt%Si alloy with (A) 0.1 and 0.4wt% of Fe showing α-Al_8Fe_2Si intermetallic phase and silicon particles.



(A) (B)

Figure 2: SEM micrographs of Al-9wt%Si alloy with (A) 0.8 and 1.2wt% of Fe showing β-Al_5FeSi intermetallic phase and silicon particles.



(A) (B)

Figure 3: SEM micrographs of Al-9wt%Si alloy with 0.8wt% of Fe showing (A) micropores limited by β-Al5FeSi and (B) β-Al5FeSi formation inside micropore.