Steel Industry Waste as Recyclable Raw Material for the Development of Ferrous-Aluminum Alloys

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Abstract : The study aims to assess if high-purity iron powder in iron-aluminum alloys can be replaced by SAE 1020 steel chips with an atomicity proportion of 50% for each element. Chips of SAE 1020 are rejected in industrial processes. Thus, the use of SAE 1020 as a replaceable composite for iron increase the sustainability of ferrous alloys by recycling industrial waste. The alloys were processed by high energy milling, of which the main advantage is the minimal loss of raw material. The raw material for three of the six samples were high purity iron powder and recyclable aluminum cans. For the other three samples, the high purity iron powder has been replaced with chips of SAE 1020 steel. The process started with the separate milling of chips of aluminum and SAE 1020 steel to obtain the powder. Subsequently, the raw material was mixed in the pre-defined proportions, milled together for five hours and then underwent a closed-die hot compaction at the temperature of 500 °C. Thereafter, the compacted samples underwent heat treatments known as sintering and solubilization. All samples were sintered one hour, and 4 samples were solubilized for either 4 or 10 hours under well-controlled atmosphere conditions. Lastly, the composition and the mechanical properties of their hardness were analyzed. The samples were analyzed by optical microscopy, scanning electron microscopy and hardness testing. The results of the analysis showed a similar chemical composition and interesting hardness levels with low standard deviations. This verified that the use of SAE 1020 steel chips can be a low-cost alternative for high-purity iron powder and could possibly replace high-purity Iron in industrial applications.

Keywords : Fe-Al alloys, high energy milling, iron-aluminum alloys, metallography characterization, powder metallurgy, recycling ferrous alloy, SAE 1020 steel recycling
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