

Abstract

This research work was funded by the Foundry Teksid S.p.A., with the aim of studying the recycling of aluminium alloy internal scraps, namely rejected parts. Teksid Aluminium is the compartment dedicated to aluminium alloy casting, is part of the Stellantis group and is located in Carmagnola (Turin, Piedmont). Teksid Aluminium is specialized in casting cylinder heads, cylinder blocks, gear boxes and suspension components through different production processes: Gravity Casting (GC), Low-Pressure Die Casting (LPDC) and High-Pressure Die Casting (HPDC).

Two alloys from Teksid production were selected for the recycling studies: AlSi7Cu0.5Mg and AlSi9Cu3(Fe).

The focus on alloy recycling represents a compelling need for the actual market, particularly the automotive market, to reduce greenhouse emissions, energy consumption and the rejected production.

Nowadays, the circular economy pushes for reducing carbon emissions: in this sense, multiple re-use of alloys without further melt treatments represents a viable alternative to reduce the carbon footprint in foundries and costs.

The primary objective of this research was to assess the recyclability of scrap alloys through a study of the alloys' mechanical properties and microstructures as a function of the scrap alloy performances after re-meltings.

In the first recycling route proposed, the gravity casting process was chosen to perform multiple castings of the alloys and evaluate the recyclability in terms of microstructures obtained. From this perspective, alloy AlSi7Cu0.5Mg, from the low-pressure die-casting production line, and AlSi9Cu3(Fe), from the high-pressure die-casting production line, were re-melted and studied. Scraps from the high-pressure die-casting process may contain a certain amount of micro-porosities that can represent a limitation in gravity casting if specific degassing processes are not performed.

Since additive manufacturing represents an attractive and highly potential new production process to realize aluminium components, the gas atomization and printing through the Laser Powder

Bed Fusion (L-PBF) process were considered in order to ennoble the scrap alloy recycling, with the aim to produce powder and evaluate the mechanical properties after printing.

Al alloy AlSi9Cu3(Fe) in both ingot and scrap forms was atomized through gas atomization. The obtained powders showed excellent rheological properties and a high grade of sphericity.

The obtained powder was then printed through L-PBF. In particular, the printing process required studying the printing parameters since the alloy AlSi9Cu3(Fe) scrap represents a new alloy for the additive manufacturing sector. The selection of printing parameters leads to obtaining highly dense specimens with high mechanical properties.

Remarkably, this thesis work aims to give a strong relation between the recycling process and obtained materials/ properties. Such properties will be evaluated from an industrial applicability point of view, to assess if a specific process/ production/ recycling route could positively affect the industrial production.

In conclusion, the thesis explores the valuable methods of recycling scraps that rise during production, suggesting promising and viable solutions to combine the themes of cost savings, circular economy, and high materials performance.

Keywords: Aluminium alloys, Gravity Casting, Re-melting, Recycling, Gas Atomization, Laser Powder Bed Fusion, Microstructure Characterization, Metal Powders, Mechanical Tests.