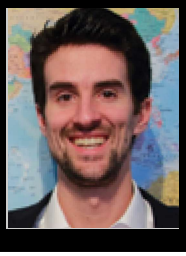
THERMAL ANALYSIS (TA) FOR DEFECT PREVENTION IN ALUMINUM CASTINGS



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ARTICLE TAKEAWAYS:

- TA prevents casting defects by assessing grain refinement & eutectic modification
- Grain refinement level is provided within 2 minutes, eutectic modification within 3 minutes

FIGURE 1
Thermal analysis sample being taken.

In this brief article, we introduce the SFTA Thermal Analysis system for aluminum foundries. We begin with measuring grain refinement, followed by examples of good and poor grain refinement and eutectic modification levels in A356. These measurements help prevent casting defects such as leaks, porosity, shrinkage, low mechanical properties, and prolonged heat treatment cycles.

WHAT IS THERMAL ANALYSIS?

Traditional thermal analysis systems for aluminum alloys, dating back to the early 2000s, measure temperature as a function of time on a sample taken from a small crucible fitted with a thermocouple (see Figure 1). For instance, these systems typically assess grain refinement by examining the liquidus recalescence (ΔT) and the recalescence time.

Recent advancements in signal processing and analysis have enhanced precision and enabled the extraction of additional information on a sample's metallurgical quality. The SFTA Thermal Analysis system uses the cooling rate curve (first derivative or dT/dt) and higher derivatives to identify phases forming during solidification (see Figure 2). Additions of master alloys like TiBor, Strontium, and Magnesium, along with chemical variations in remelts versus primary ingots, influence phase formation during the sample's transition from liquid to solid.

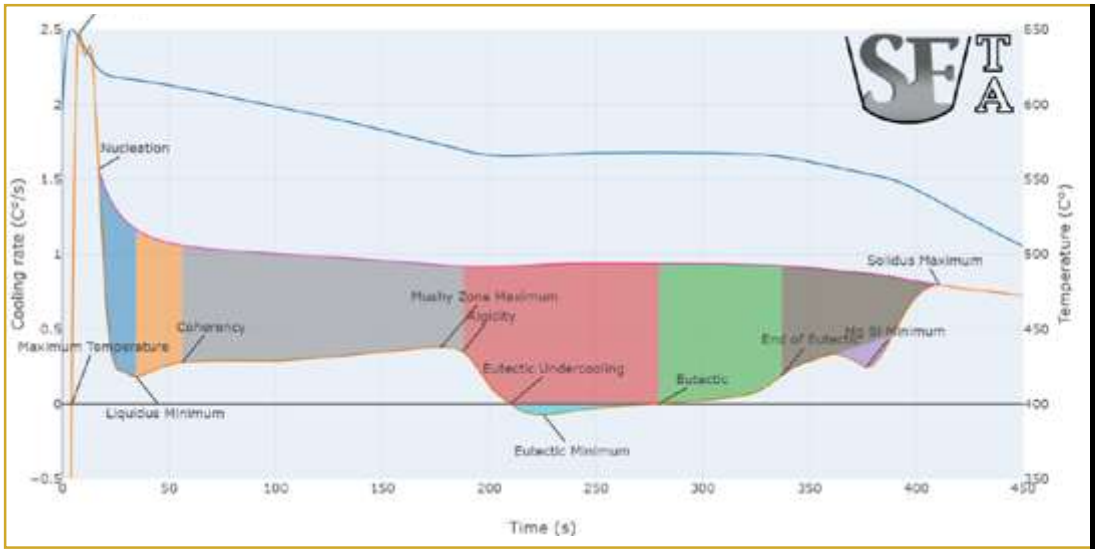

FIGURE 2
Complete cooling curve of a A356 sample after degassing, TiBor and Strontium additions. The blue curve is temperature versus time and the orange curve is the cooling rate or first derivative dT/dt. The higher derivatives are not shown here.

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WHY TAKE A THERMAL ANALYSIS SAMPLE?

The primary purpose of a thermal analysis sample is to ensure that the melt has optimal properties before casting, helping to prevent defects. This approach provides operators with data-driven guidance (see Figures 3 and 4).

While solidification properties like eutectic modification and grain refinement can be measured through metallography, this process is more costly and time-consuming than thermal analysis (see Figures 5–6 and 6–7). The thermal analysis sample determines grain refinement within 2 minutes, modification level within 3 minutes, and provides the full cooling curve in 6 minutes.

FIGURE 3
Furnace operator interface before melt treatment for aluminum A356 (No-Go)

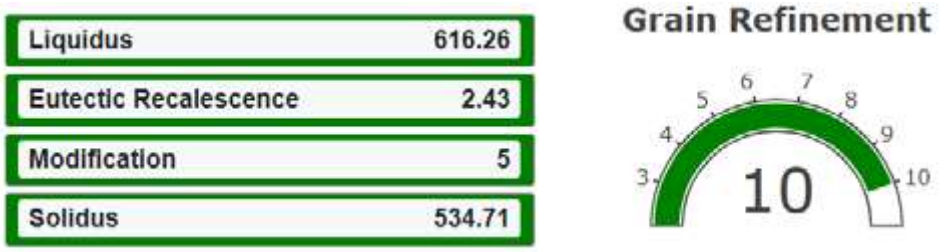

FIGURE 4
Furnace operator interface after melt treatment for aluminum A356 (Go)

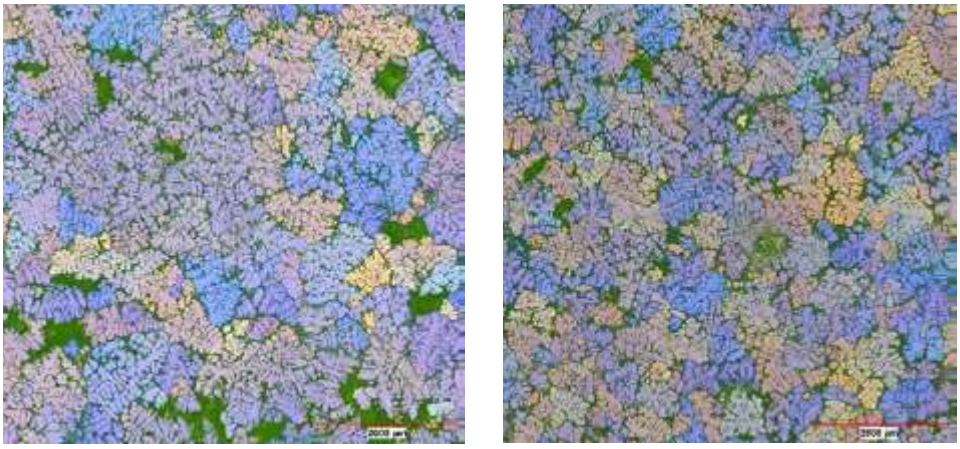

FIGURE 5
A356 metallography before (left, 141 grains/cm2) and after (right, 291 grains/cm2) Tibor master alloy additions for grain refinement.

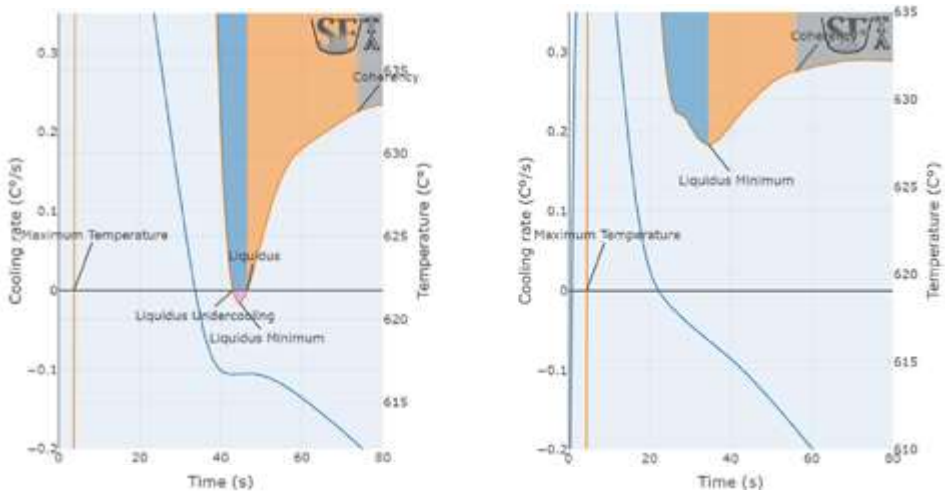

FIGURE 6
A356 thermal analysis samples before and after grain refinement (see figure 5).

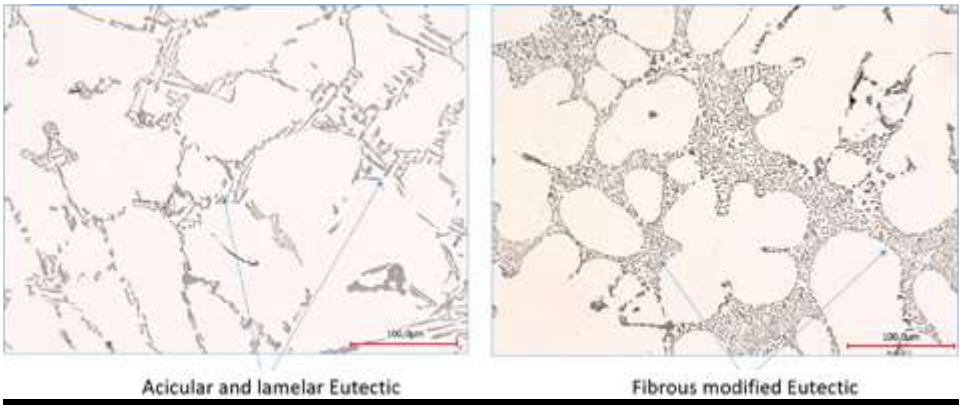

FIGURE 7
A356 metallography before (on the left) and after (on the right) strontium additions to modify the eutectic.

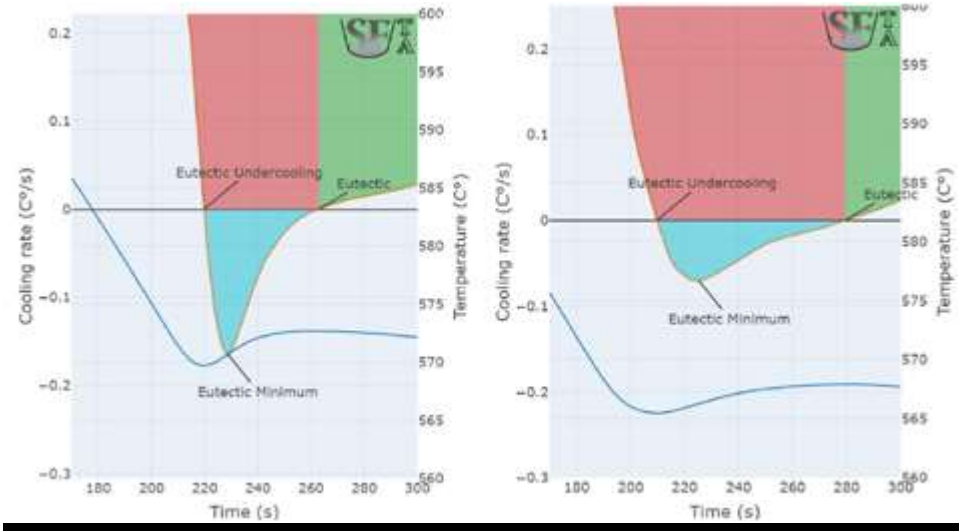

FIGURE 8
A356 thermal analysis samples before and after strontium additions (see figure 7).

In conclusion, most foundries use SFTA thermal analysis samples to confirm grain refinement and eutectic modification treatments before pouring, much like they rely on RPT samples for degassing checks or spectrometer samples for chemical composition. Additionally, advanced thermal analysis can help foundries reduce scrap by measuring Mg_2Si and Al_2Cu intermetallics, optimizing heat treatment cycles, and incorporating the actual fraction solid curve in casting simulation software.

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SFTA Thermal Analysis for Aluminum

BETTER MELT CONTROL REDUCES DEFECTS

The SFTA Thermal Analysis System offers a complete solution for measuring solidification properties directly on the shop floor—in just 3 to 6 minutes!

Features:

- Measure eutectic modification & grain refinement
- Evaluate the intermetallics Mg_2Si, Al_2Cu
- Diagnostic tool for detecting casting defects
- Easily calibrated by your operators

Finally, an affordable and comprehensive solution to quickly adjust melt treatment, reduce defects, and increase production.

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