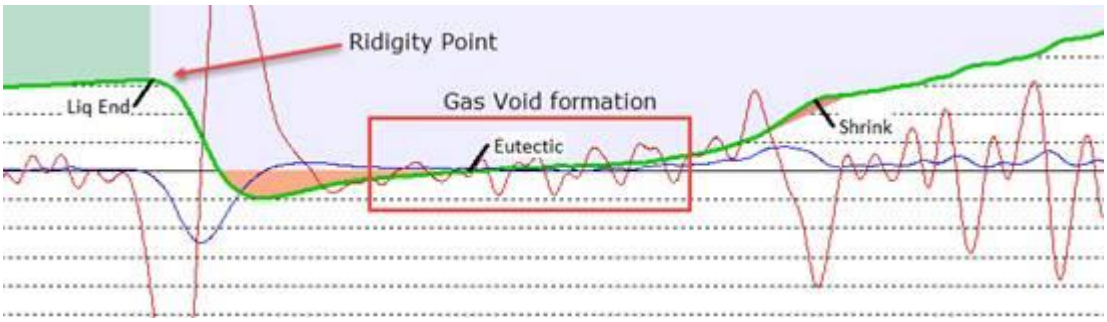
Hydrogen Presence in Aluminum

The presence of hydrogen in aluminum generally results in the formation of bubbles (voids), as the partial pressure of the hydrogen gas increases to the point of overcoming any internal pressures. The process MeltLab has to offer involves keeping background noise to a minimum in order to isolate and look for the correct endothermic signatures in the cooling curves.

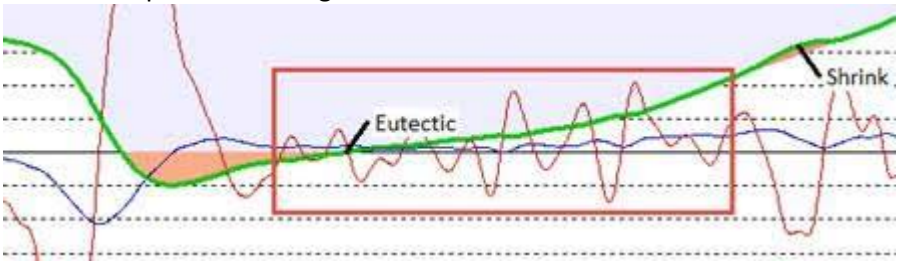
Experience suggests that these inflection points of bubble formation should be expected after the rigidity point and before typical shrinkage events, if the hydrogen is present in significant amounts. Of course, any remaining hydrogen would come out during a shrinkage event as well; it just depends on how much gas is necessary to generate its own event. Presumably, other methods of hydrogen determination rely on more expensive Instrumentation and sampling costs.

We will need to calibrate the thermal analysis responses to more traditional methods of measuring hydrogen to determine a way of converting the thermal arrests into more traditional hydrogen evaluation results.

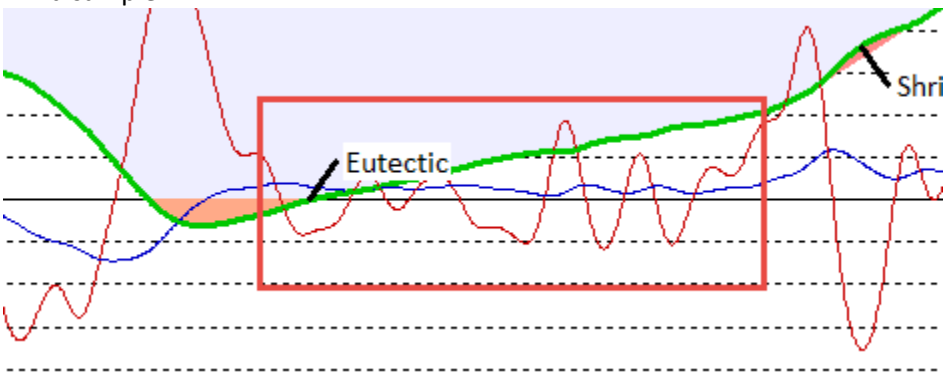
The first sample below was degassed, and shows only minor void formation. In the picture, green represents the 1st derivative inverted (rate of cooling), blue represents the second derivative, and red is the third derivative. This sample is a 319 alloy with some shrinkage (0.14% of the heat of fusion energy in the largest endothermic arrest). The hydrogen seems to be coming out mostly after the recalescence caused by modification.



Second sample with more gas



Third sample



One consideration is that gas void formation may reduce the amount of shrinkage, as both processes relieve stress in the casting. Therefore, one metric of success in controlling the outcome of the finished metal would be the reduction of either gas and shrinkage effects, or at least balancing the two in the direction of the least negative effect.

MeltLab is also in the process of re-designing the aluminum stand; we are moving away from the Pechiney-style stand, as it is too clumsy and hard to maintain. The curve pictured above was taken on the newly designed stand, and is at the moderate level of smoothing. Professor Han of the University of Purdue has shared some of his research on how gas bubbles form in the spaces between dendrites as the partial pressure changes. It will be fairly easy to calculate a value for this phenomenon once we have a second method of comparison (measurement). We will likely be able to calculate numbers for hydrogen concentrations at lower thresholds than most other equipment can capture.

If your foundry would be interested in Hydrogen measurement as well as the shrinkage behavior and other features of Aluminum MeltLab Microstructure, please contact us for further information.

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