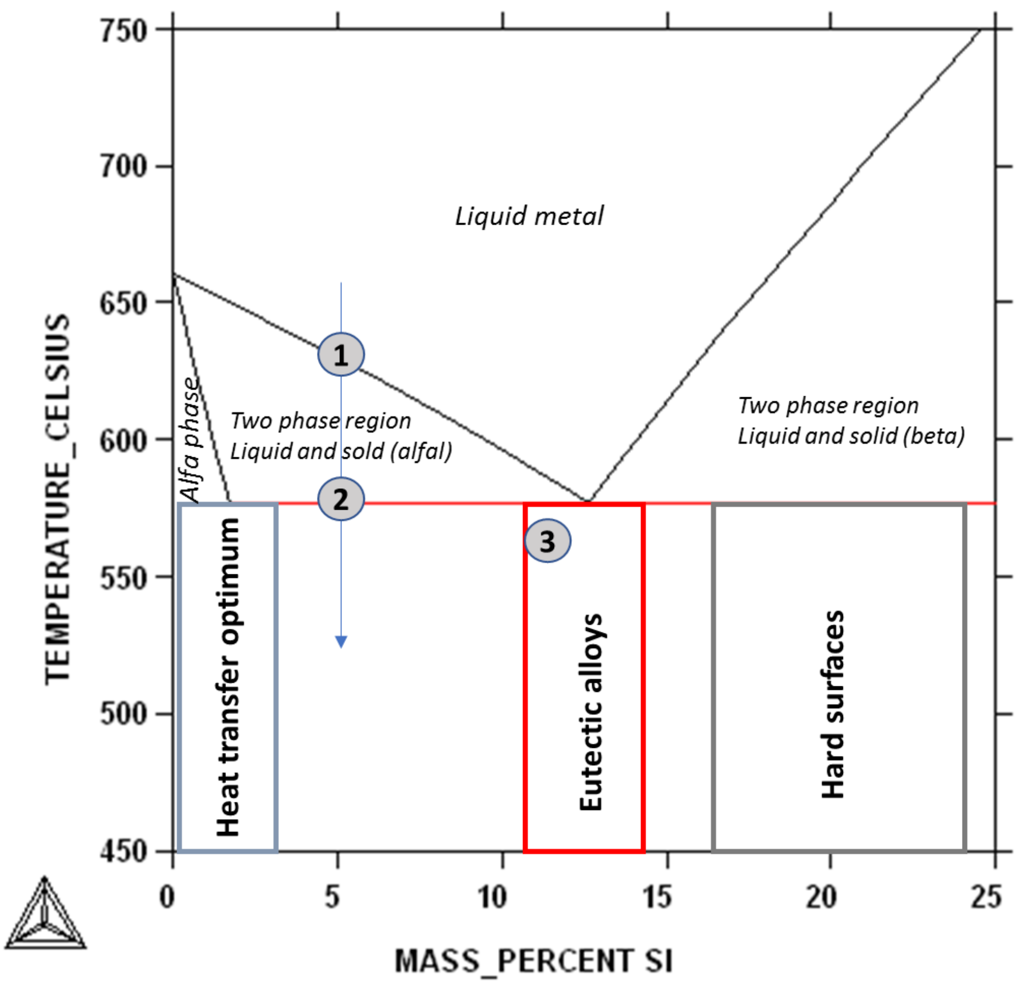
ALLOYS FOR RHEOCASTING, GENERAL DESCRIPTION

Background
The alloy selection for semi solid processes is most often a choice between different functions and characteristics, but there must always be a melt interwall.

The melt interwall
The meaning of a melt interwall is the temperature difference between point 1 and 2 in the phase diagram. The practical benefit from the melt interwall is that in the zone between the liquidus line and the solidus line there is a two-phase region where physics gives us a melt containing both sold and liquid material. However, having two phases gives a melt, but this melt must be modified to avoid formation of dendrites.

The phase diagram
Below is the traditional phase diagram for Aluminum and Silicon. Please note that the temperature scale is in Celsius,



About alloying elements
Aluminum is rarely used in its pure form, there are almost always different elements to reach certain desired functionalities. The most common additive alloys used are the following:

- Silicon (Si), used to increase strength and to avoid melt interwall as for high pressure de casting. Silicon is the most common element and it is almost always used.
- Copper, used to reach very high strengths, but the drawback is more corrosion sensitive
- Magnesium, gives a better elongation but as Mg is reacting with oxygen in the air the melt handling must be performed with care.

For semi solid casting all alloying elements are of interest as they increase the melt interwall hence giving the opportunity for more advanced castings.

General alloy zones in the phase diagram
The selection of alloys can be directed through checking the phase diagram and some examples are shown below:

The non castable zone
In the ditch of solidus lines there is a point, denoted 3 in the phase diagram, were there are no melt interwall why semi solid techniques can not be used to cast these alloys. In this region we find alloys like 44300 and 43400 and those are purely high pressure die casting alloys.

Heat transfer, heat management
To reach high levels of thermal conductivity an alloy with very low amounts of Si must be used, to the left in the phase diagram, as the Si often forms plate lake insulation barriers in the metal matrix. Other alloy elements are used in small amounts to create a melt interval and Comptech AB has made parts with as low as 1,5 %Si, reaching >210 W/mK.

Pressure tight and very thin walls
The thinner the walls in combination with demand for leak free components the better feeding the foundry must achieve. This leads to a search of alloys with the broadest melt interwall possible why we find those ideal semi solid alloys in the region of 5-7% Si, as for example the A356 alloy that has been used extensively in semi solid research. Quite often these alloys also have a low price why they are of interest for high volume production.

High hardness
To reach hardness and often to have tougher surface that can withstand wear the use of over eutectic alloys are of interest. This means that alloys ranging 17-25% Si are interesting as the metal matrix then contains. One aspect is that these alloys requires high temperatures even with semi solid and thus will wear the tooling quicker.

High elongation alloys
To reach high elongation the foundry must work both with specific alloys as well as with the casting process. Magnesium content in the alloys means that protective gas must be applied. Alloy content to be checked regularly in the production for every batch and other testing applies. But also, the microstructure is providing results and the most important factor is porosity that must be kept to a minimum.