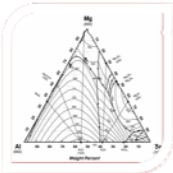
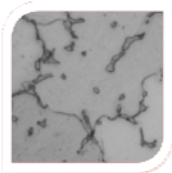
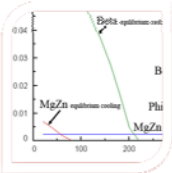
Thermodynamic calculations course project:

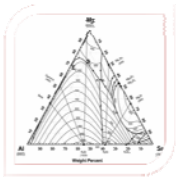
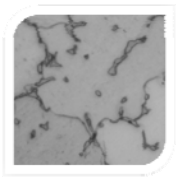
Effect of Strontium additions on AZ31 precipitated phases, microstructures and mechanical properties.

Alireza Sadeghi

Outline

- Mg-Al-Zn-Sr quadric system
  - Intermetallic precipitates
  - Mg-Al-Sr + 1%Zn ternary phase diagram
  - Mg-Zn-Al-Sr isothermal binary phase diagram
  - AZ31-Sr binary phase diagram
- Verifying the calculations
  - Selecting compositions
  - Casting, annealing and optical microscopy
- Cooling curves in solidification
- Conclusion

Mg-Al-Zn-Sr QUADRIC SYSTEM

Mg-Al-Zn-Sr quadric system → Intermetallic precipitates

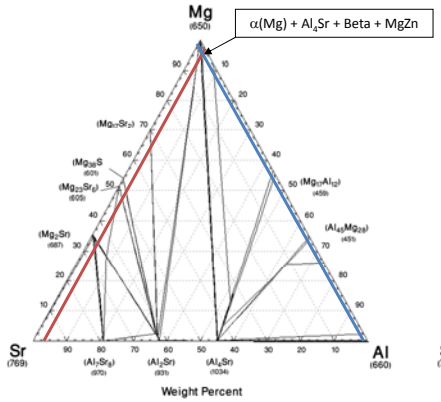
Binary intermetallics

$$Mg + \begin{cases} Al \rightarrow Mg_{17}Al_{12} \\ Zn \rightarrow MgZn \\ Sr \rightarrow Mg_{17}Sr_2 \end{cases} \quad Al + Sr \rightarrow \begin{cases} Al_4Sr \\ Al_2Sr \end{cases} \quad Zn + Sr \rightarrow SrZn_5$$

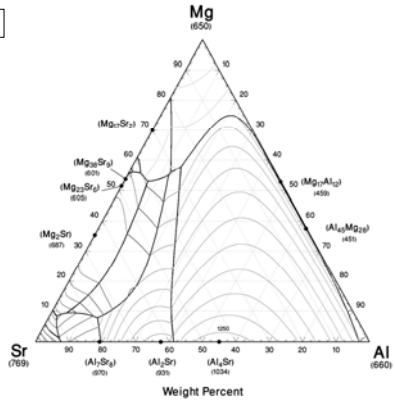
Ternary intermetallics

$$Mg + Al + Sr \rightarrow Mg_{13}Al_3Sr\,, Mg_{16}(Al, Zn)_2Sr\,, \ldots$$

Mg-Al-Zn-Sr quadric system → Mg-Al-Sr + 1%Zn ternary diagram



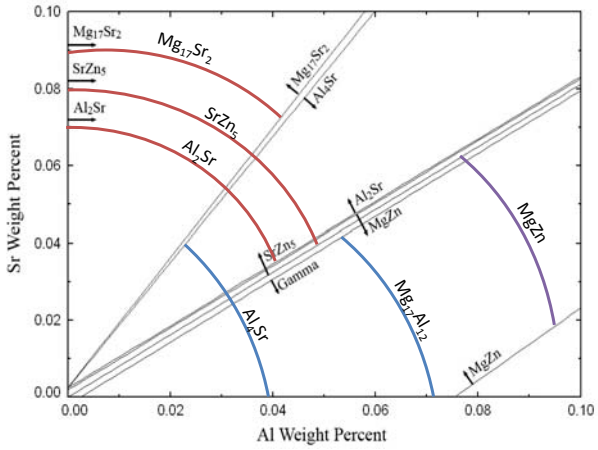
Isothermal phase diagram in room temperature



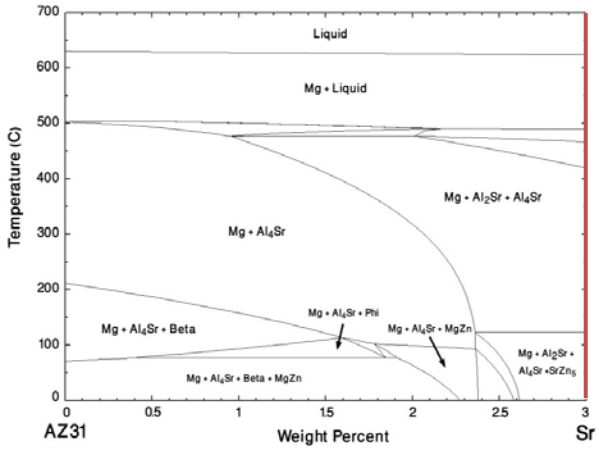
Calculated liquidus projection

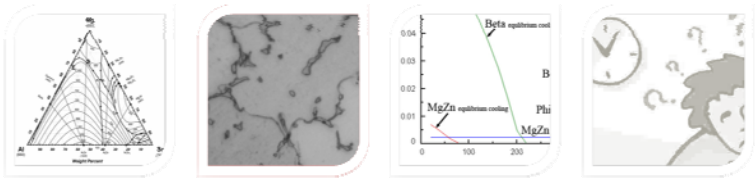
Thermodynamic calculations course project:
Effect of Strontium additions on AZ31 precipitated phases, microstructures and mechanical properties.

Mg-Al-Zn-Sr quadric system → Mg-Zn-Al-Sr isothermal binary phase diagram



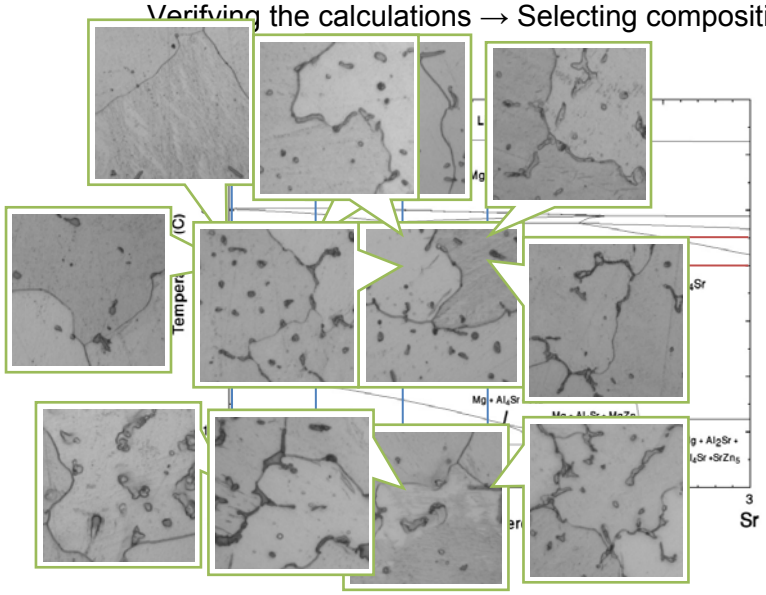
Mg-Al-Zn-Sr quadric system→ AZ31-Sr binary phase diagram



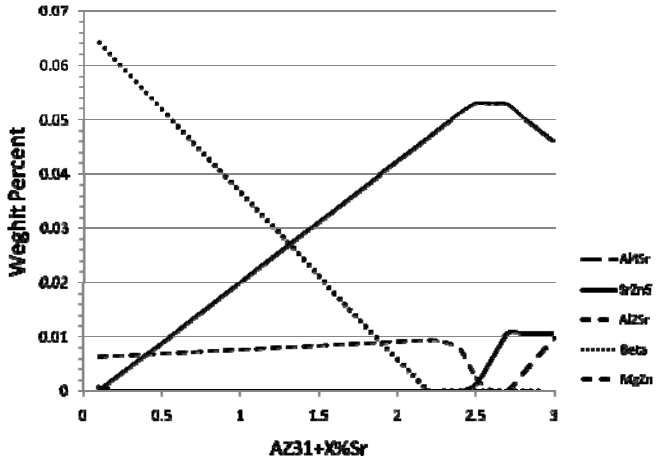


VERIFYING THE CALCULATIONS

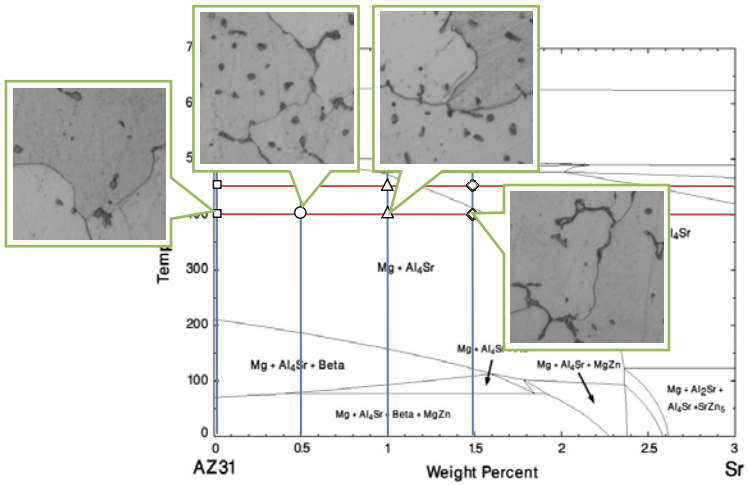
Verifying the calculations → Selecting compositions

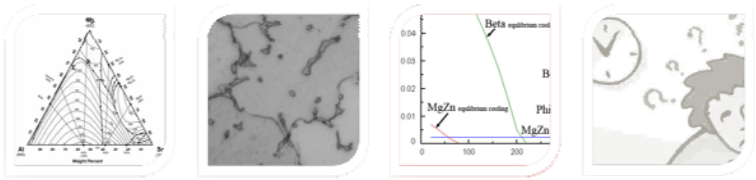


Precipitation vs. wt% of Strontium



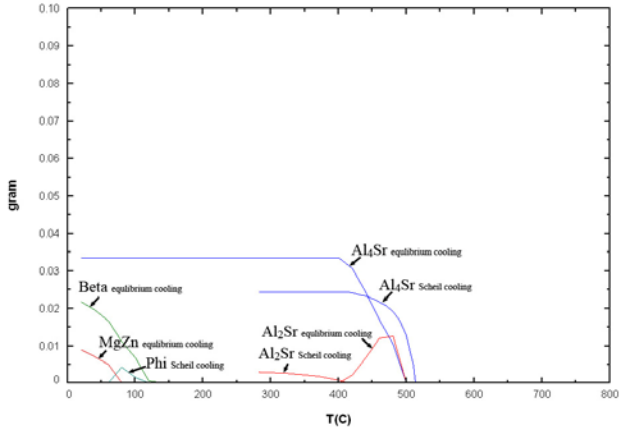
Verifying the calculations → Selecting compositions



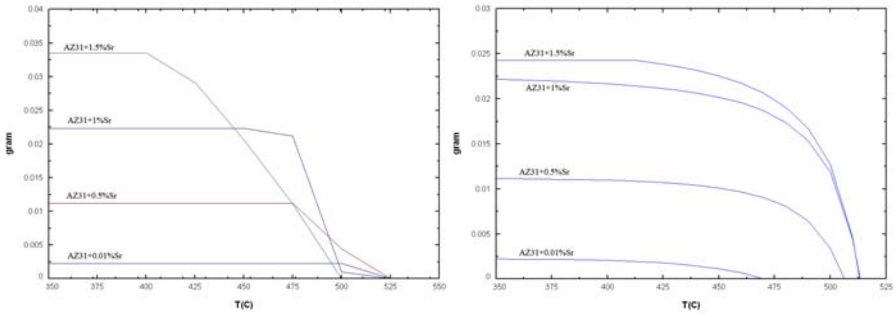


COOLING CURVES IN SOLIDIFICATION

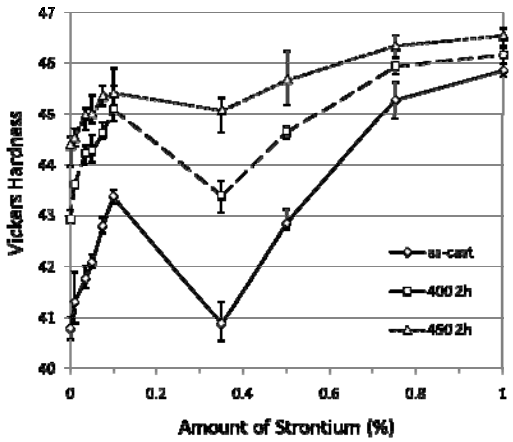
Cooling curves in solidification

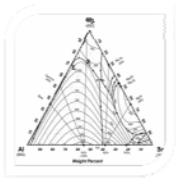
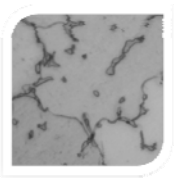
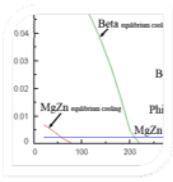


Al_4Sr Scheil and equilibrium cooling



Vickers hardness tests



CONCLUSION

Conclusions

1. FactSage is a powerful tool for predicting thermal behavior of precipitates in as-cast and annealing conditions.
2. FactSage has been used to predict precipitation during casting and further annealing. Experimental results verify the overall trends.
3. Scheil cooling provides more precise information about the cast structure.
4. There are some deviations from calculations in real material, which could have different sources. One of the most important ones is not considering the possible ternary phases in calculations.

Questions?

THANKS FOR YOUR ATTENTION