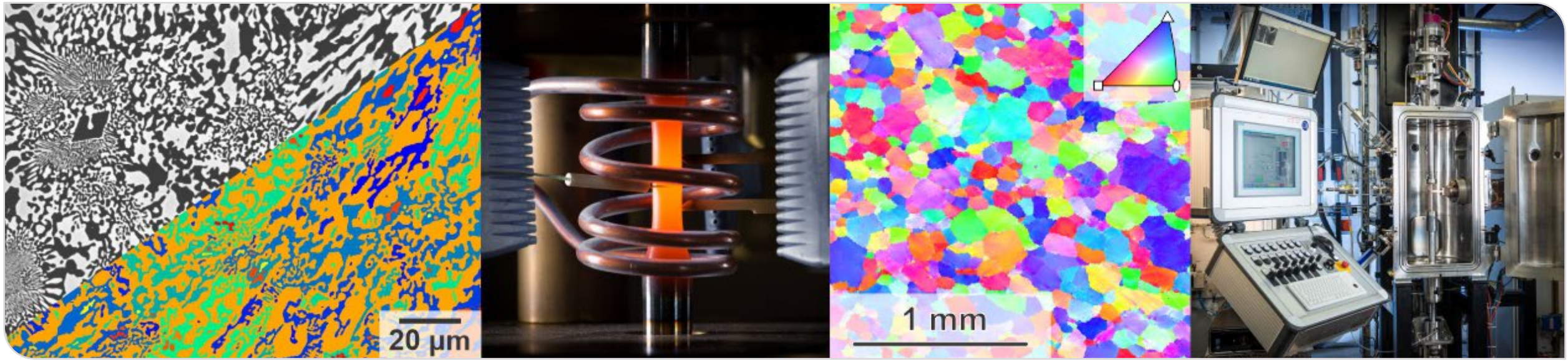
Karlsruhe Institute of Technology

IAM
Institute for Applied Materials

Phase Transformations in Materials

Lecture for “Mechanical Engineering” and “Materials Science and Engineering”
Dr.-Ing. Alexander Kauffmann (Bldg. 10.91, R. 375)
Dr. Sandipan Sen (Bldg. 10.91, R. 311)

Version 24-01-24

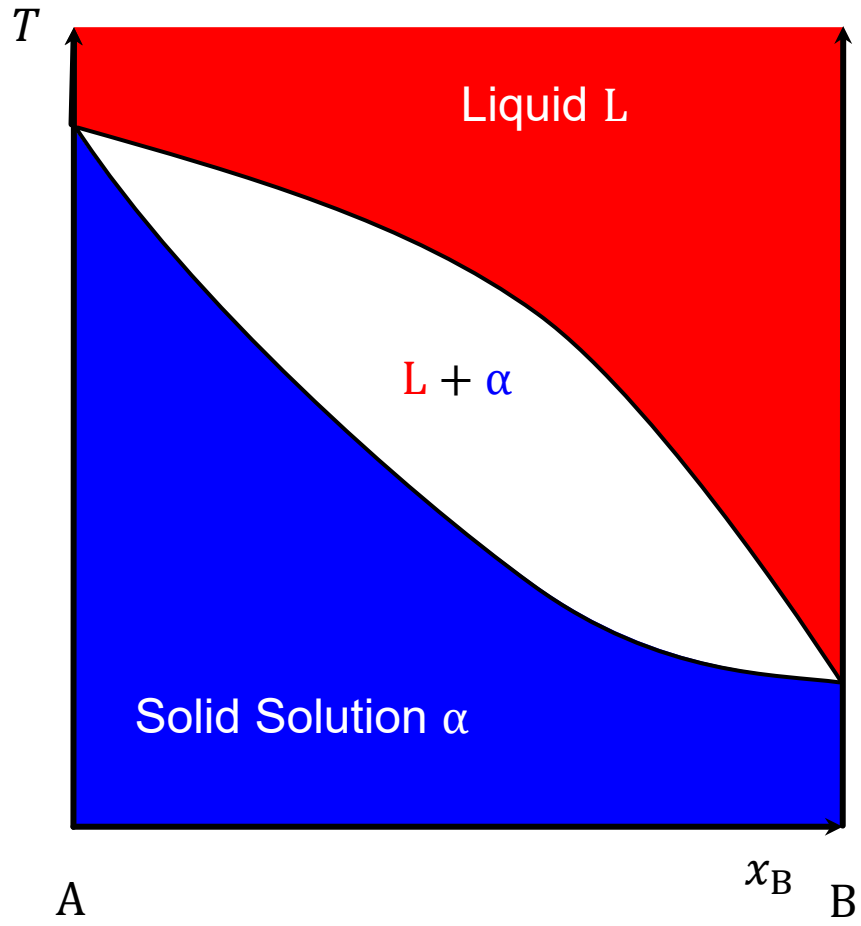


Topics

- Other Types of Reactions in Binary Systems
  - Fundamental Types of Binary Phase Diagrams
  - Eutectic
  - Peritectic and Peritectic Reactions
  - Less Common Types
    - Monotectic
    - Metatectic/Catatectic
    - Syntectic

Fundamental Types of Binary Phase Diagrams

- In the preceding sections, we have seen several type of fundamental binary phase diagrams that are:
  - Complete Miscibility (Cigar)
  - Complete Miscibility (Maximum)
  - Complete Miscibility (Minimum)
  - Miscibility Gap



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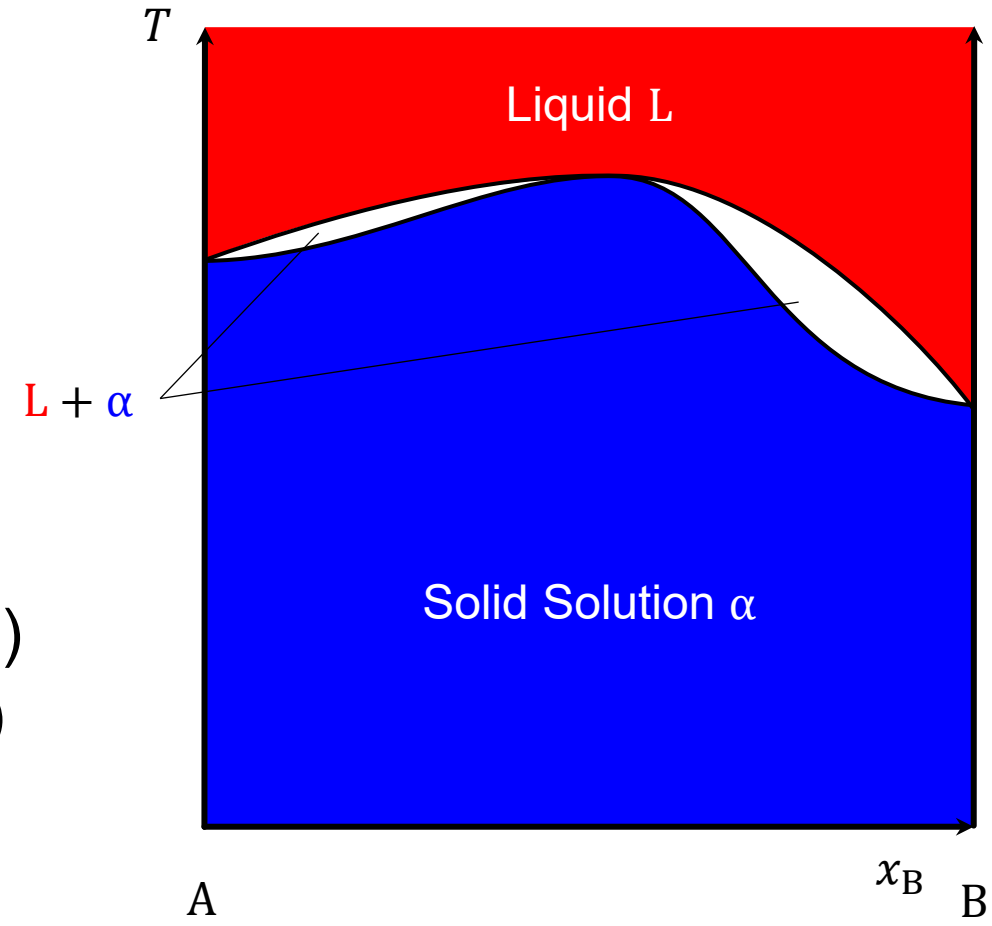

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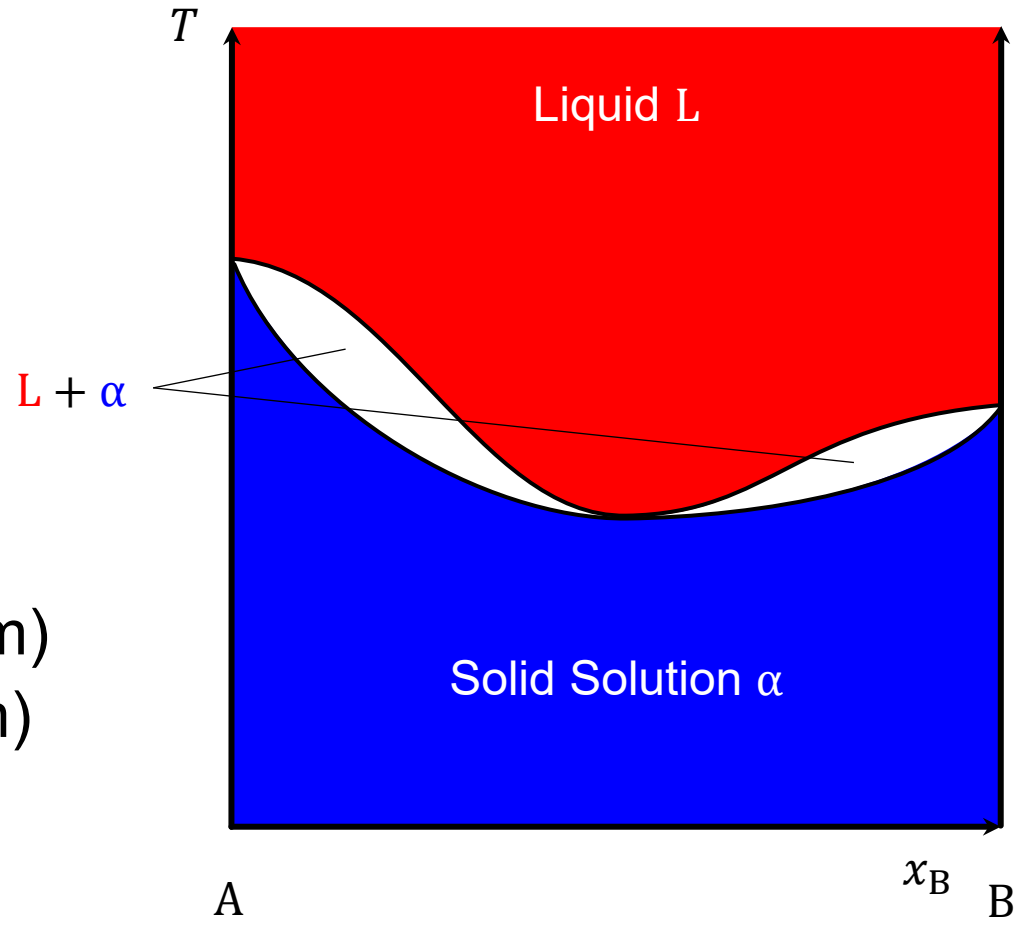

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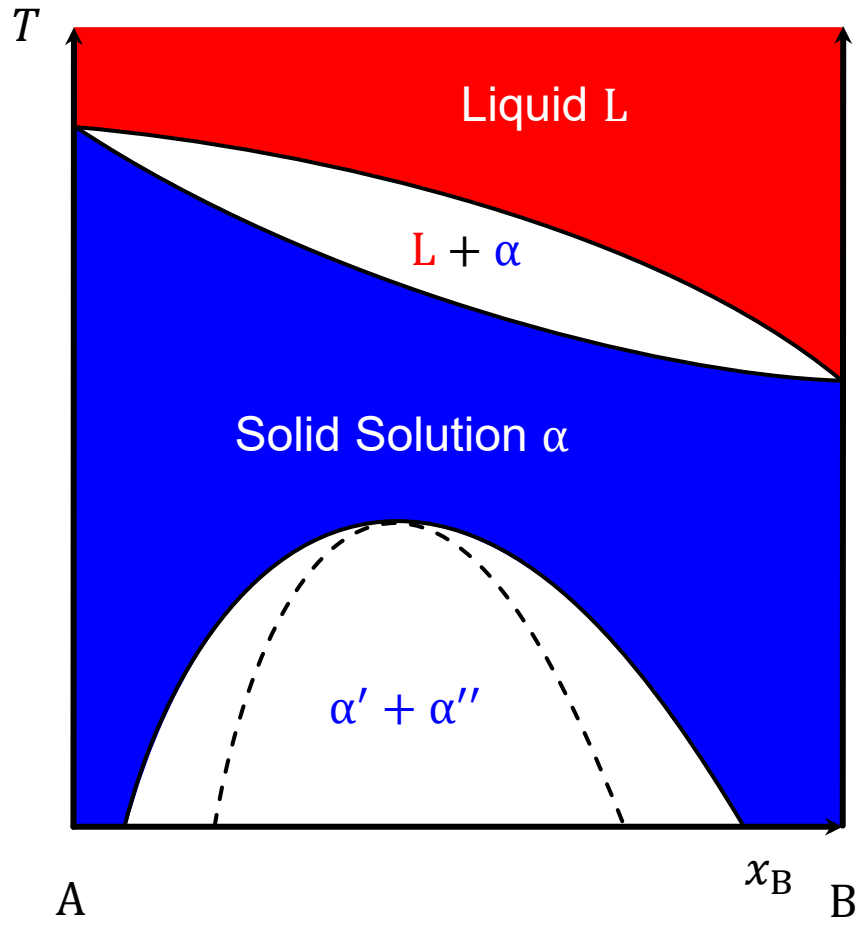

Eutectic Systems

- More complex phase diagrams are obtained by combinations of these:
  - *Eutectic (inv.* $L \rightleftharpoons \alpha + \beta$*)*
    by a miscibility gap approaching the two-phase regions of solid and liquid in a phase diagram with minimum in the liquidus curve (see Ch. 4d)
  - *Peritectic (inv.* $L + \alpha \rightleftharpoons \beta$*)*
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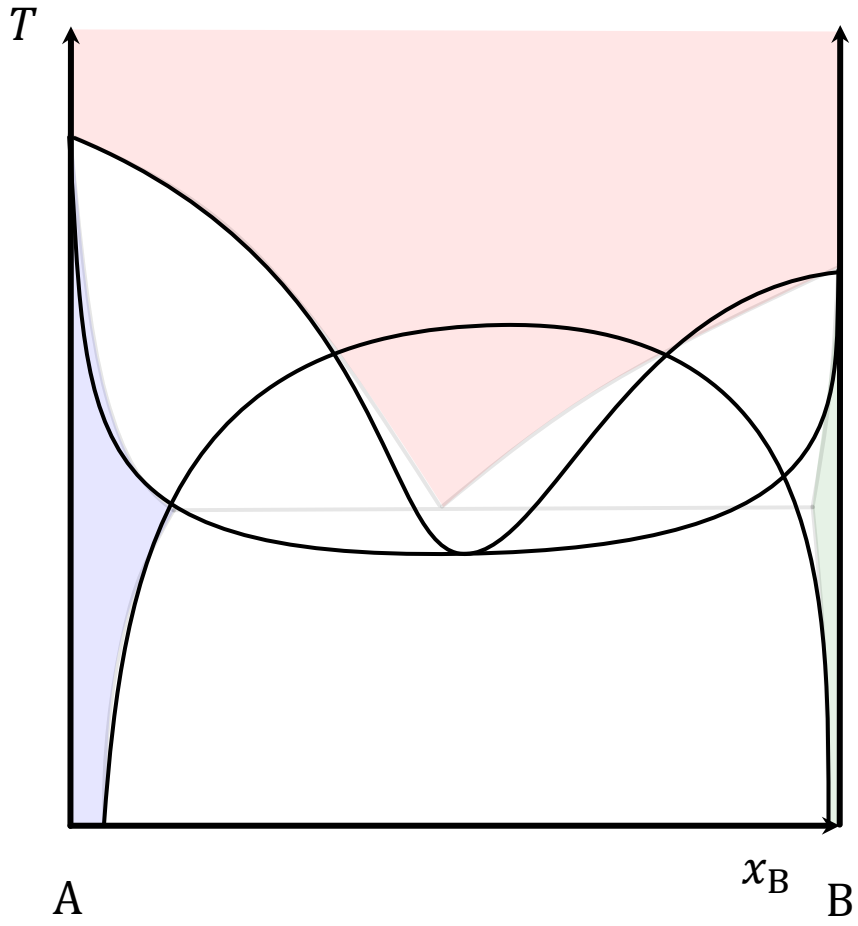

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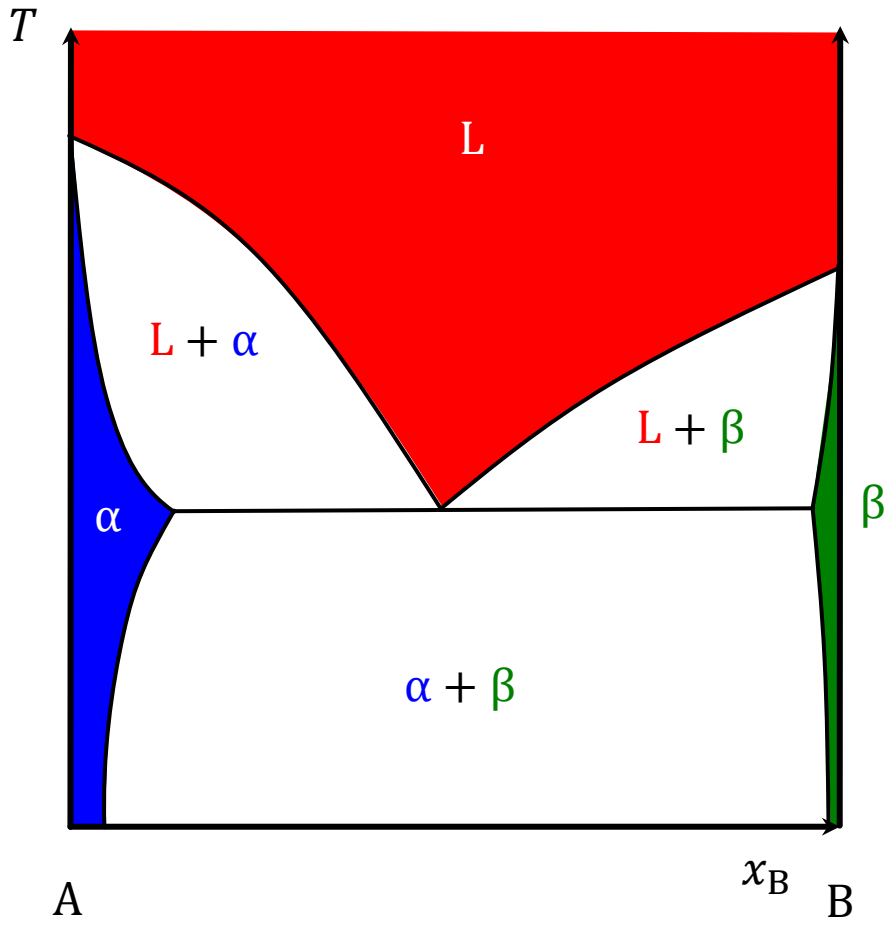

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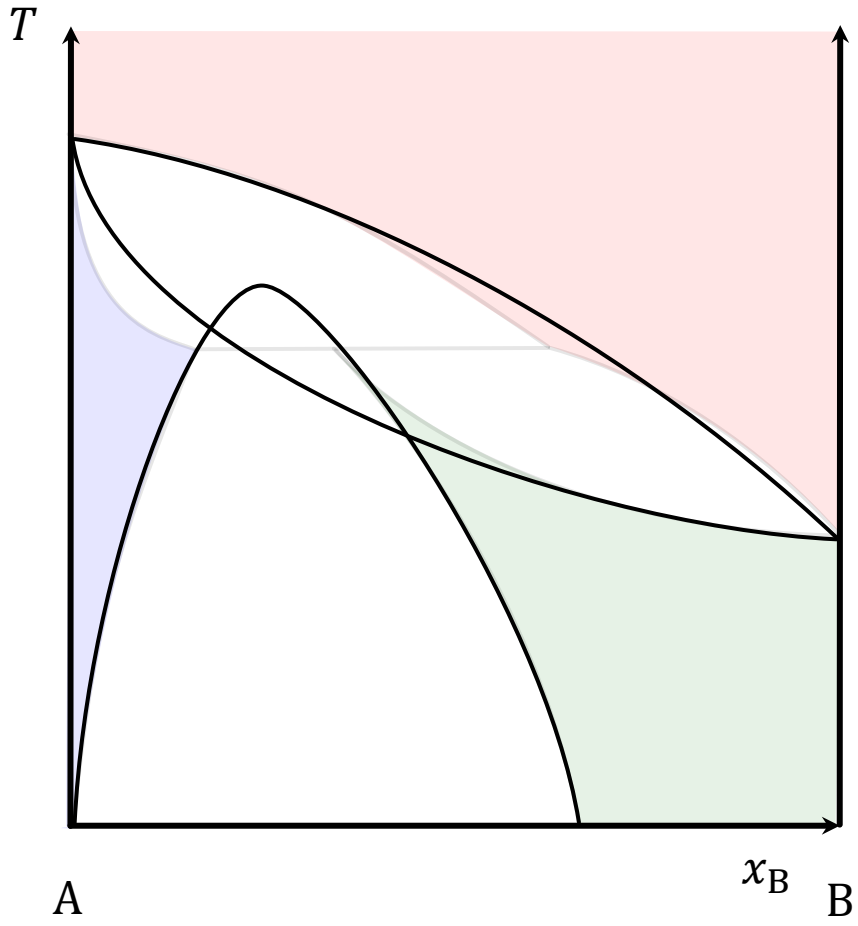

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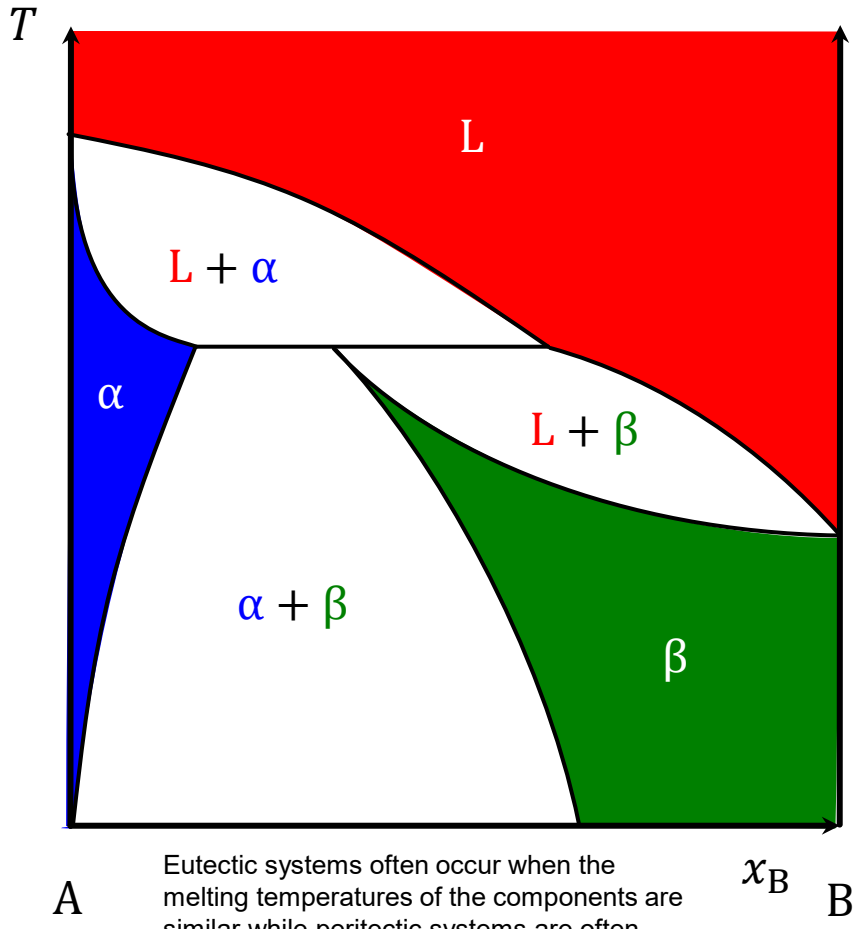
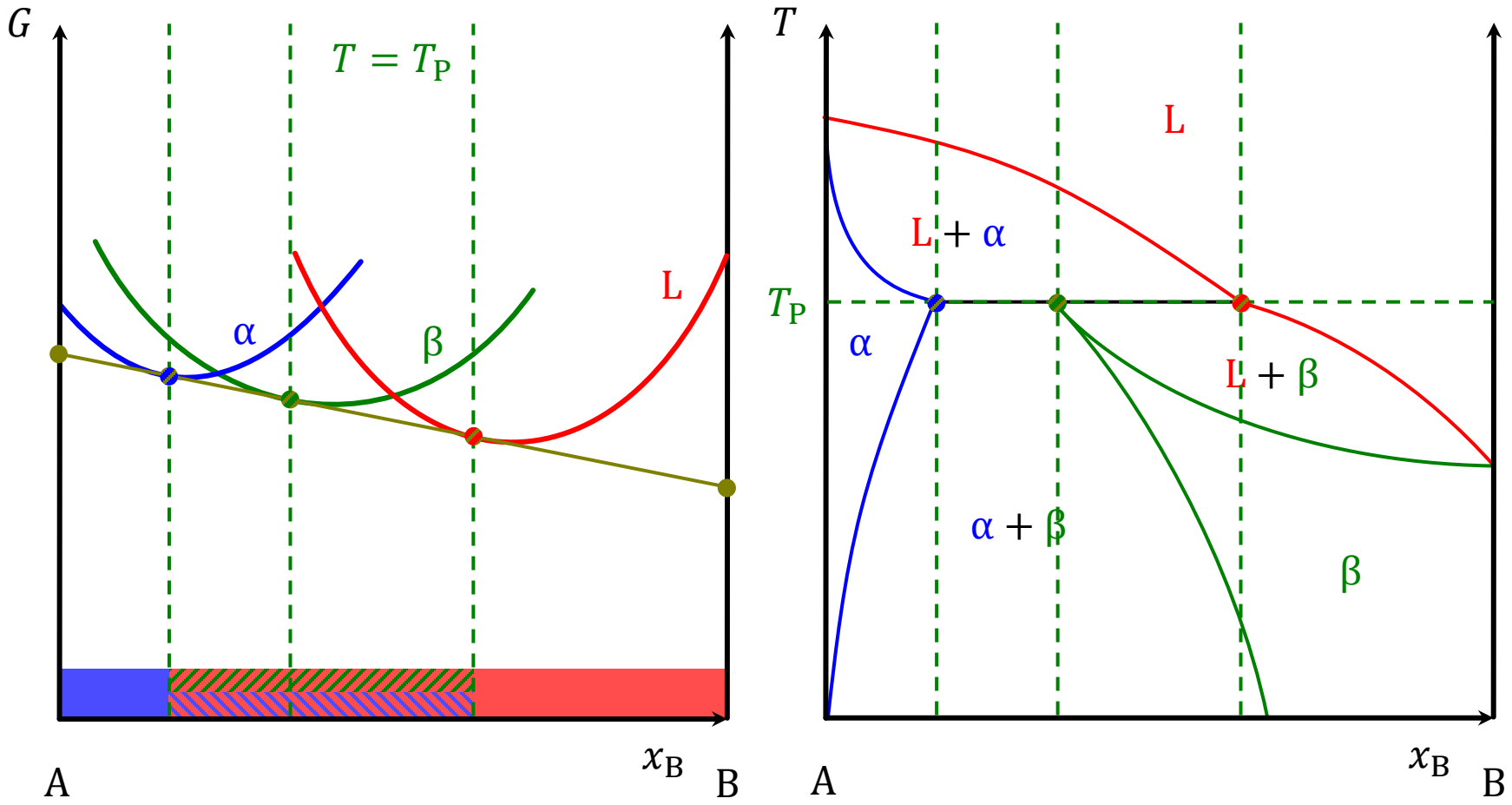


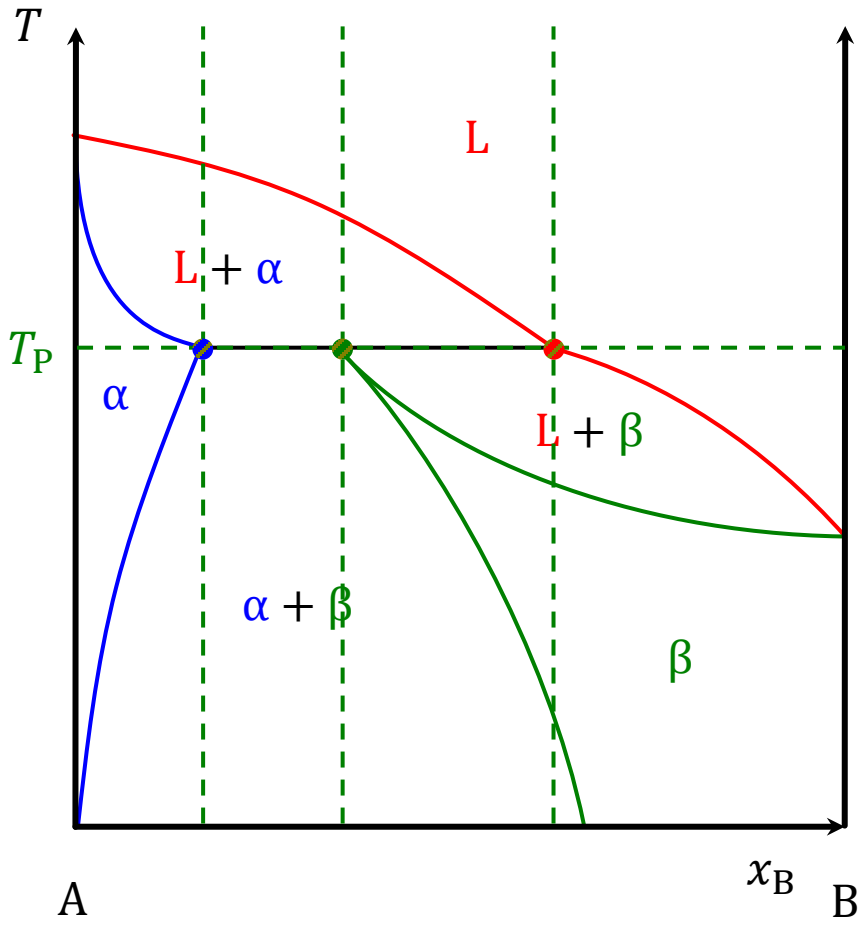
Eutectic systems often occur when the melting temperatures of the components are similar while peritectic systems are often obtained when they are very different. Many exceptions from this rule exist.

Peritectic Systems



Peritectic Reaction

- Solidification through the L + α region leads to similar solidification conditions as described in Chs. 4a & b with segregation and constitutional super cooling.
- For the peritectic reaction L + α → β to occur fast, a contact of the three phase would be required similar to the triple line during a eutectic reaction with L → β + α.
- The peritectic reaction starts at the interface between the primarily solidified α and the remaining liquid L.



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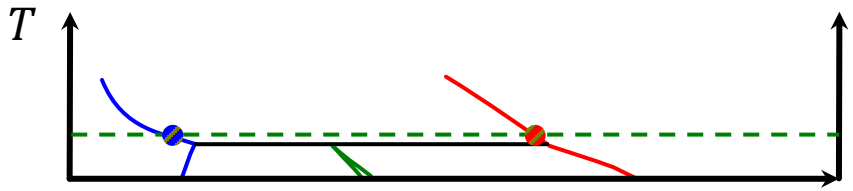

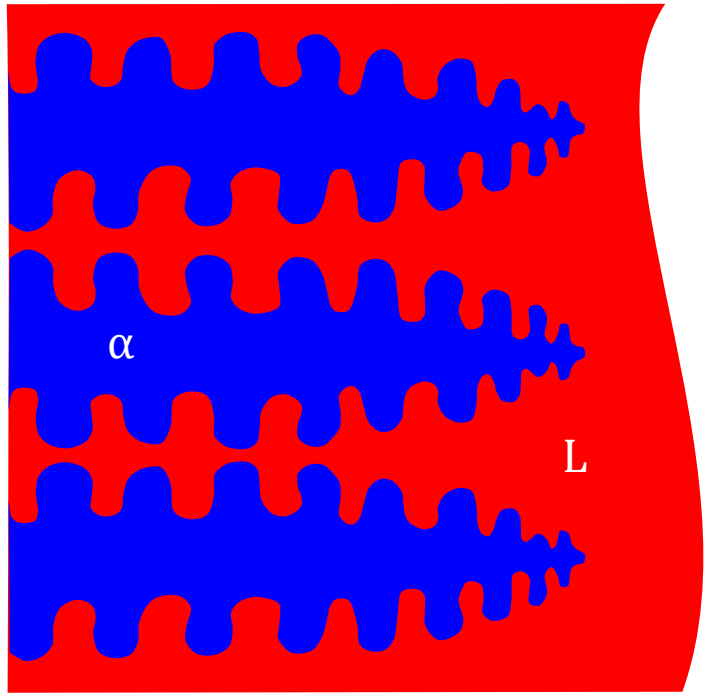

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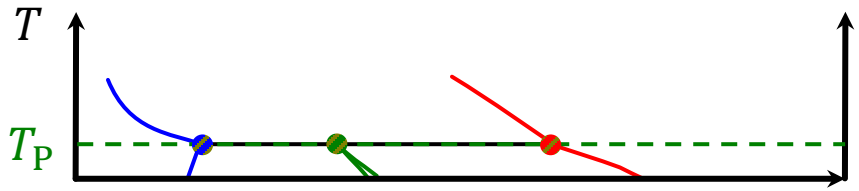
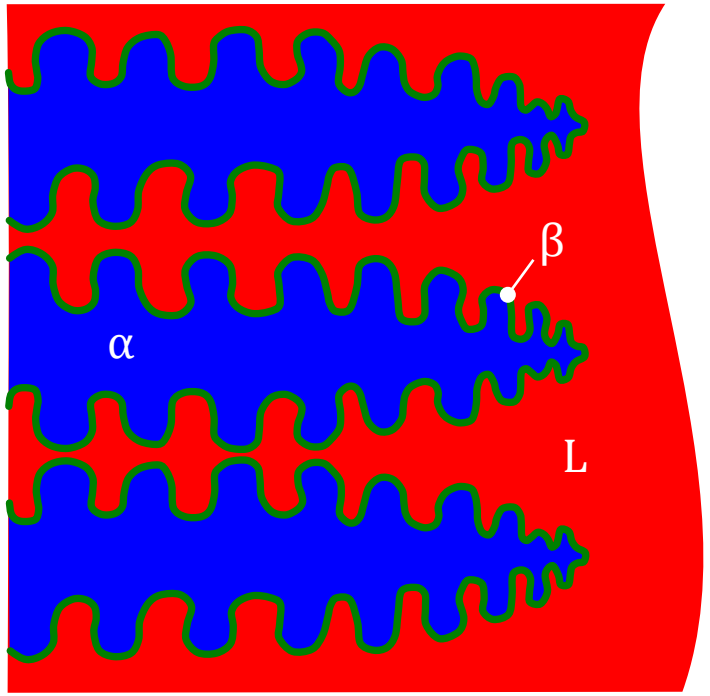
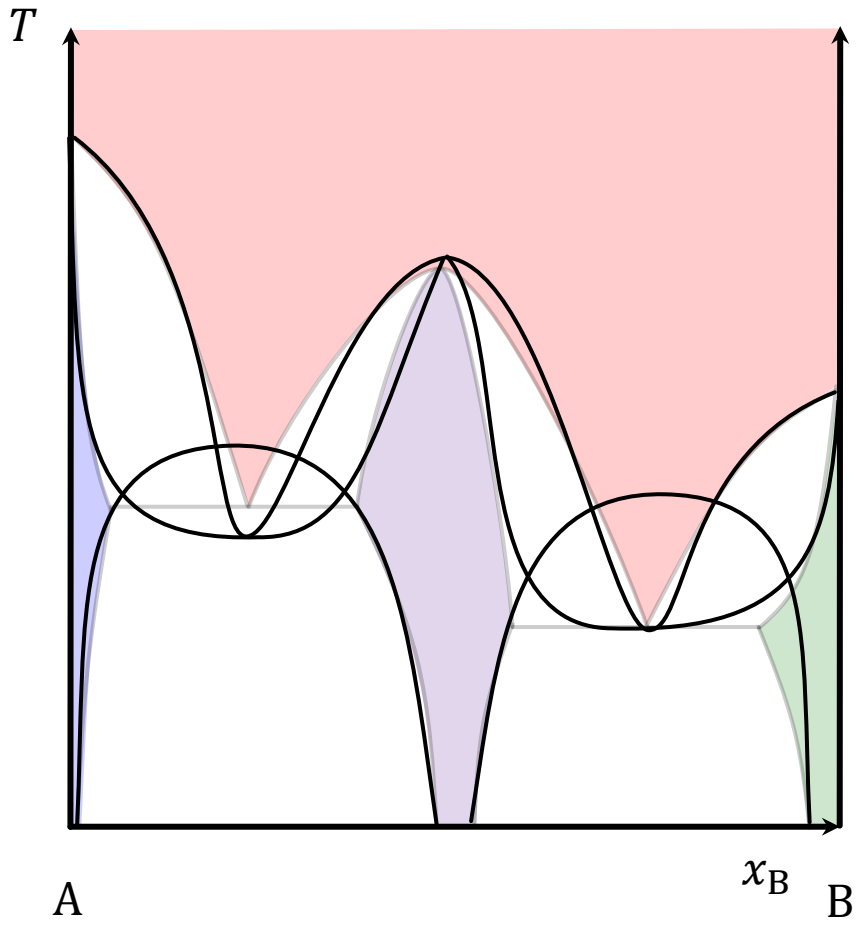




Congruently Melting Intermetallic Compounds

- In the case of $\Delta H^{\mathrm{mix}} \ll 0$ ($\varepsilon \ll 0$), ordered intermetallic compounds can form directly from the liquid.
- Similar to congruently melting alloys, these intermetallic compounds can solidify like pure elements with a direct transition from the liquid to the solid without compositional change.



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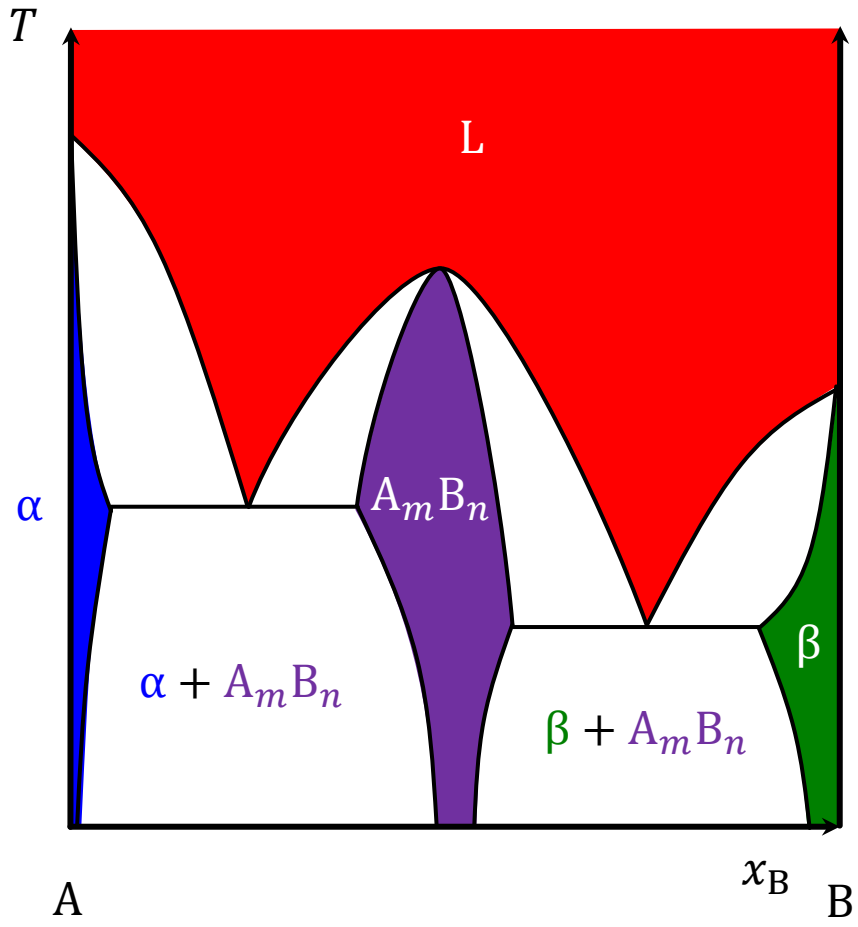

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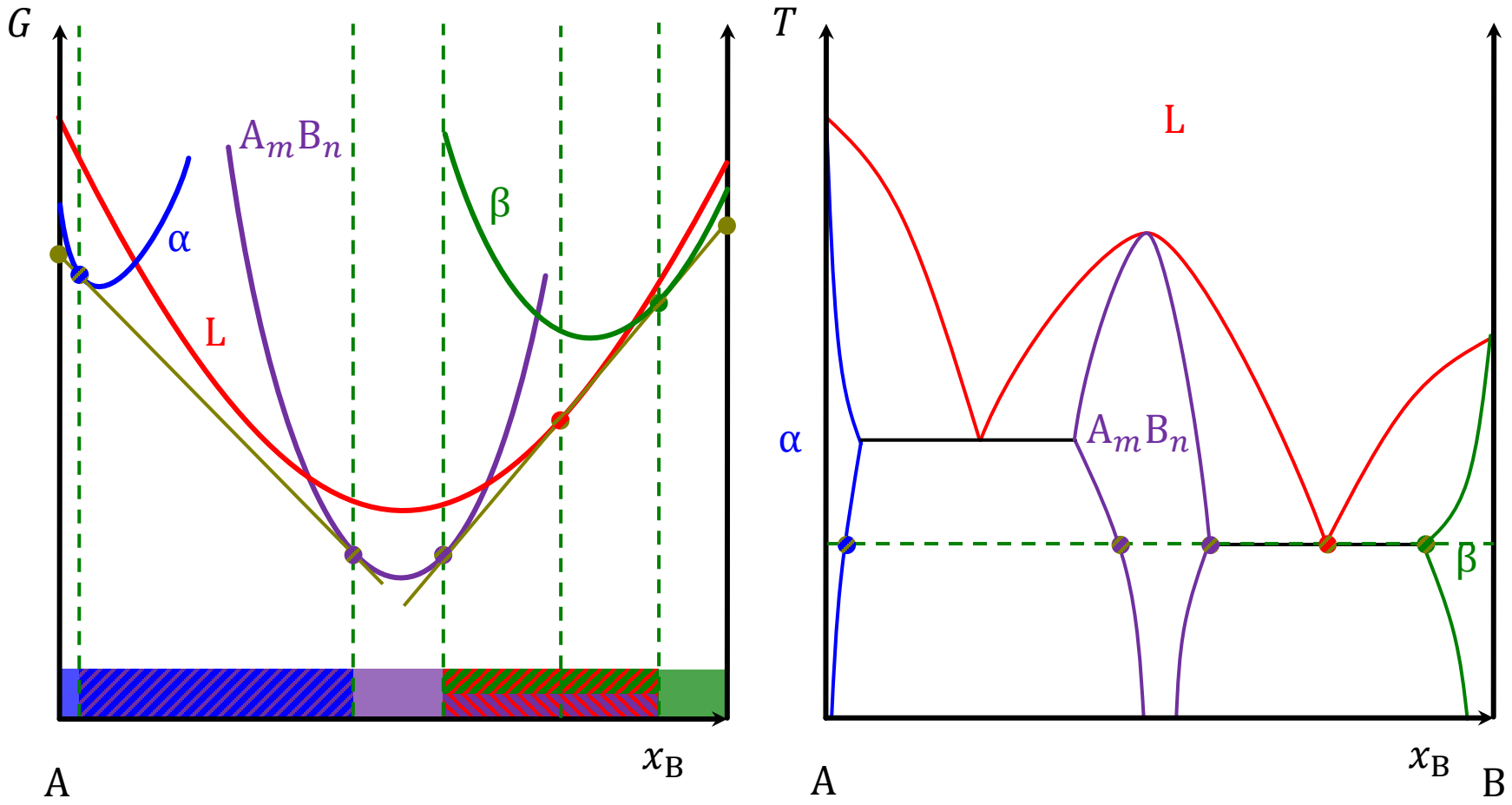

Less Common Types

- Less common types might be:
  - *Monotectic*
    (inv. $L' + \alpha \rightleftharpoons \alpha + L''$*)*
    by miscibility gap in the liquid & cigar-like two-phase region
  - *Metatectic/Catatectic*
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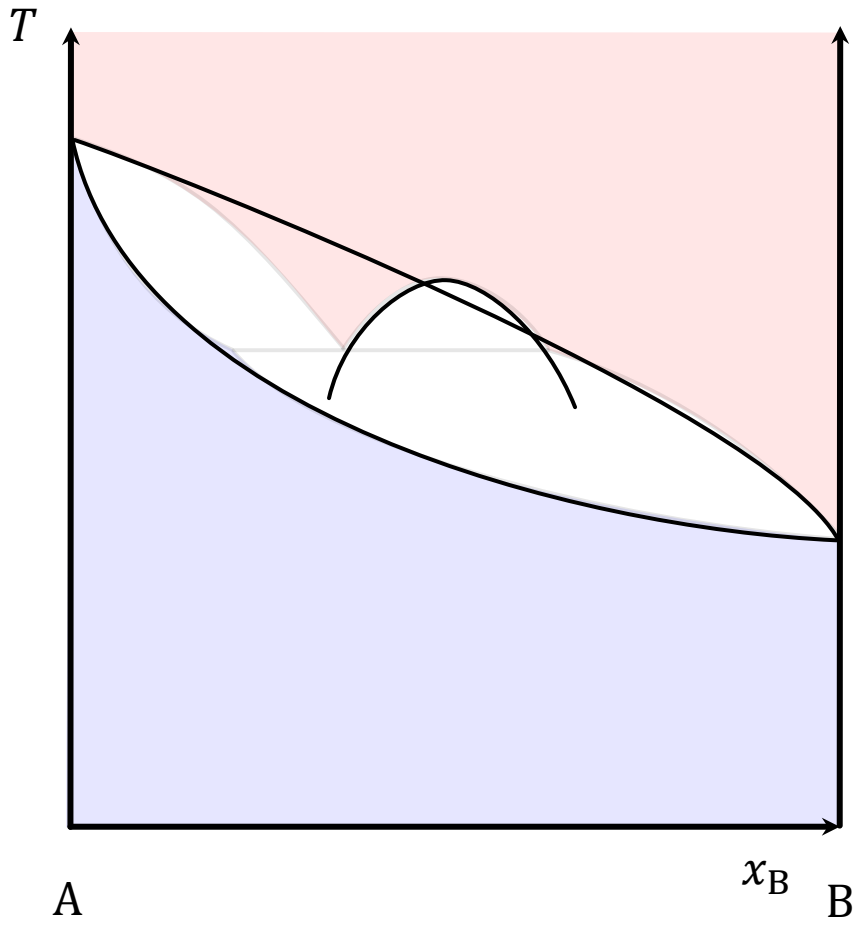

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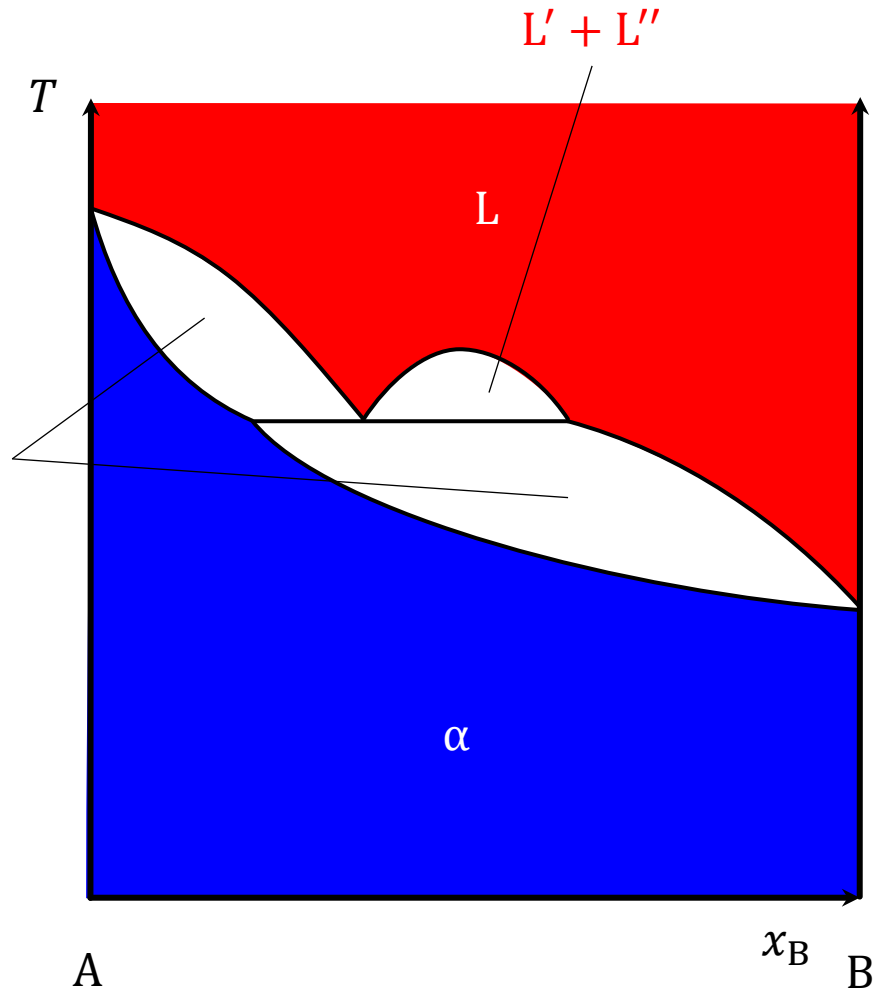

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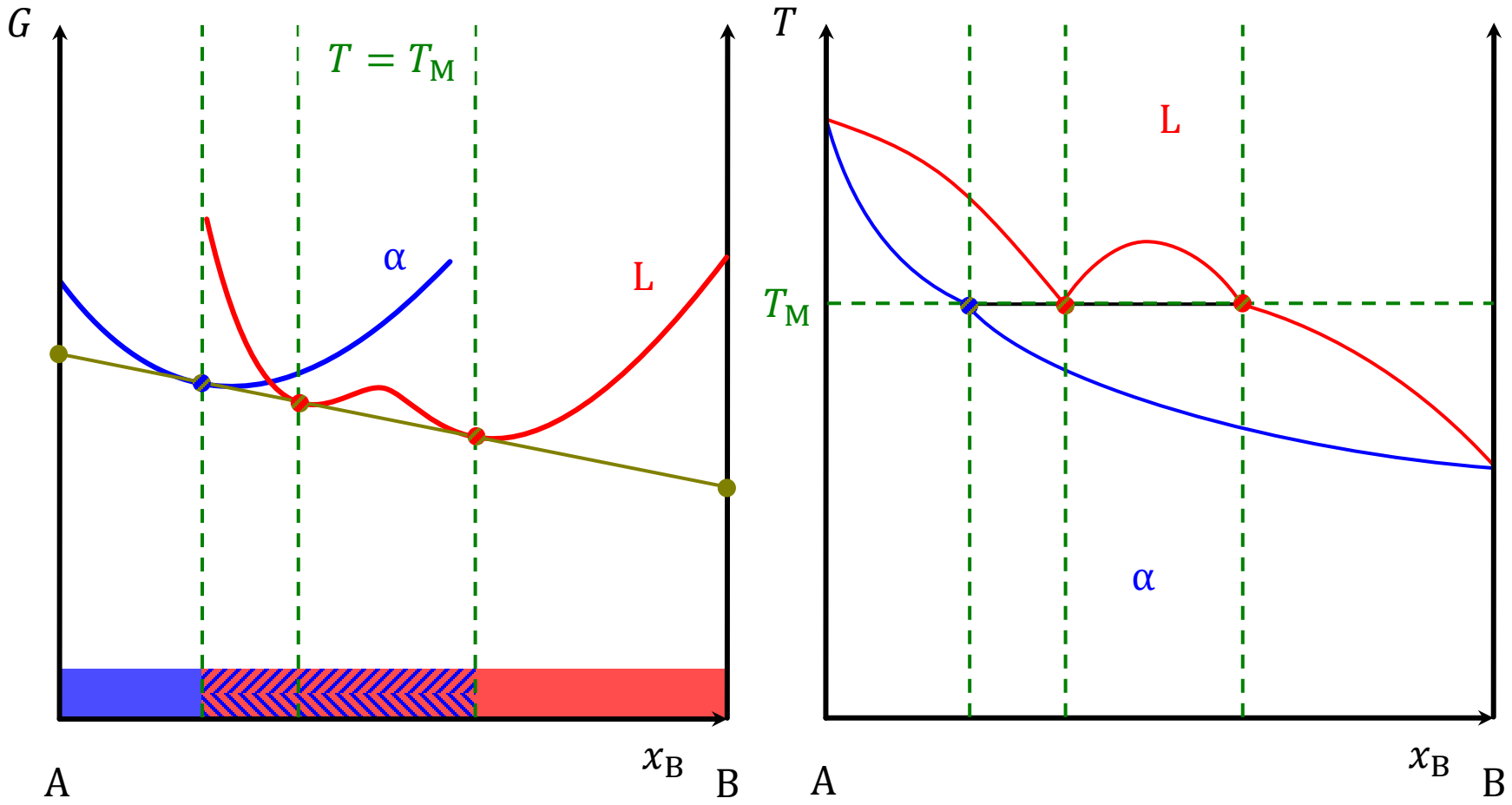

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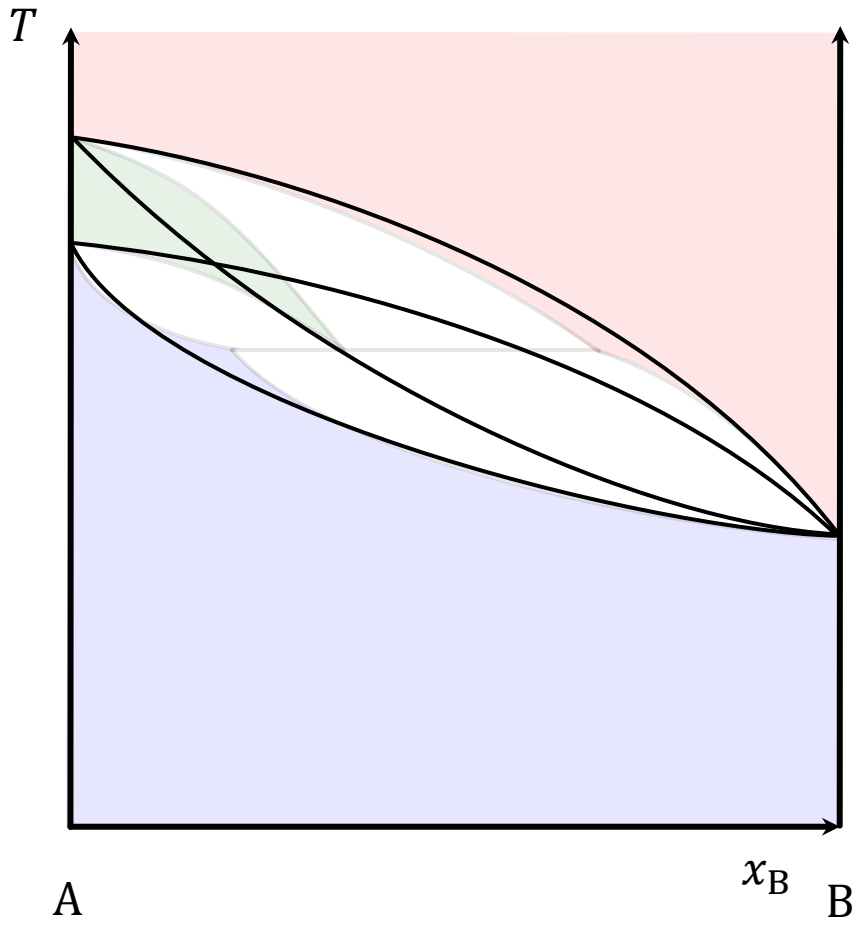

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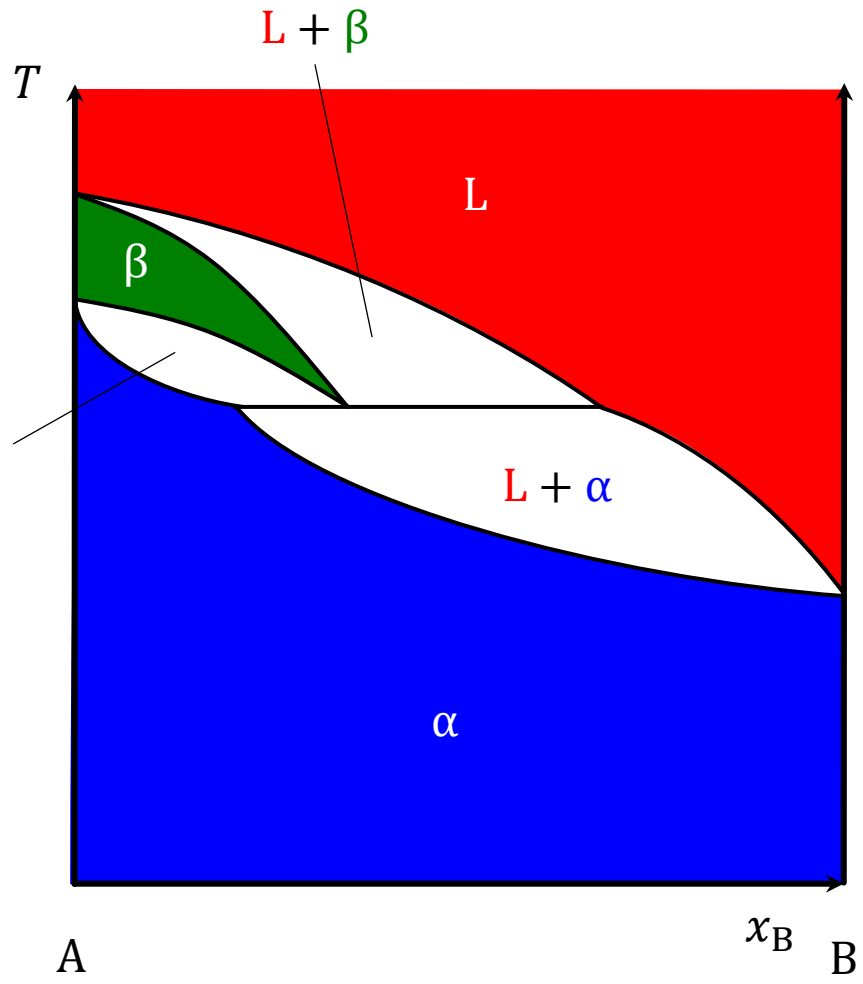

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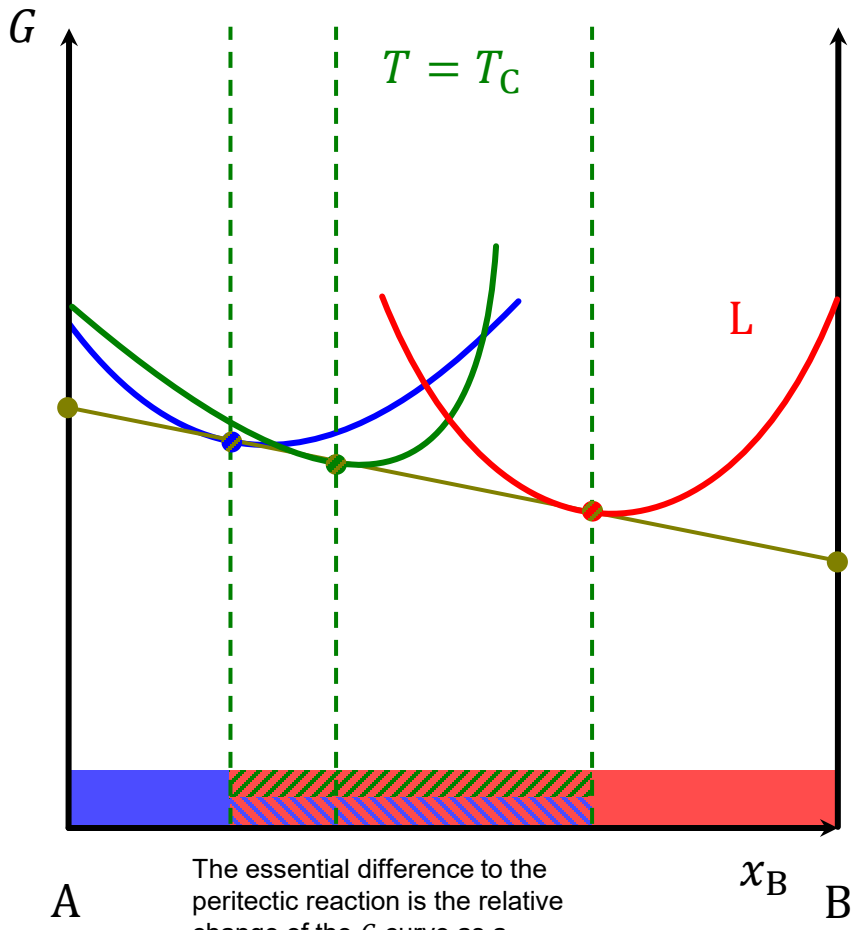
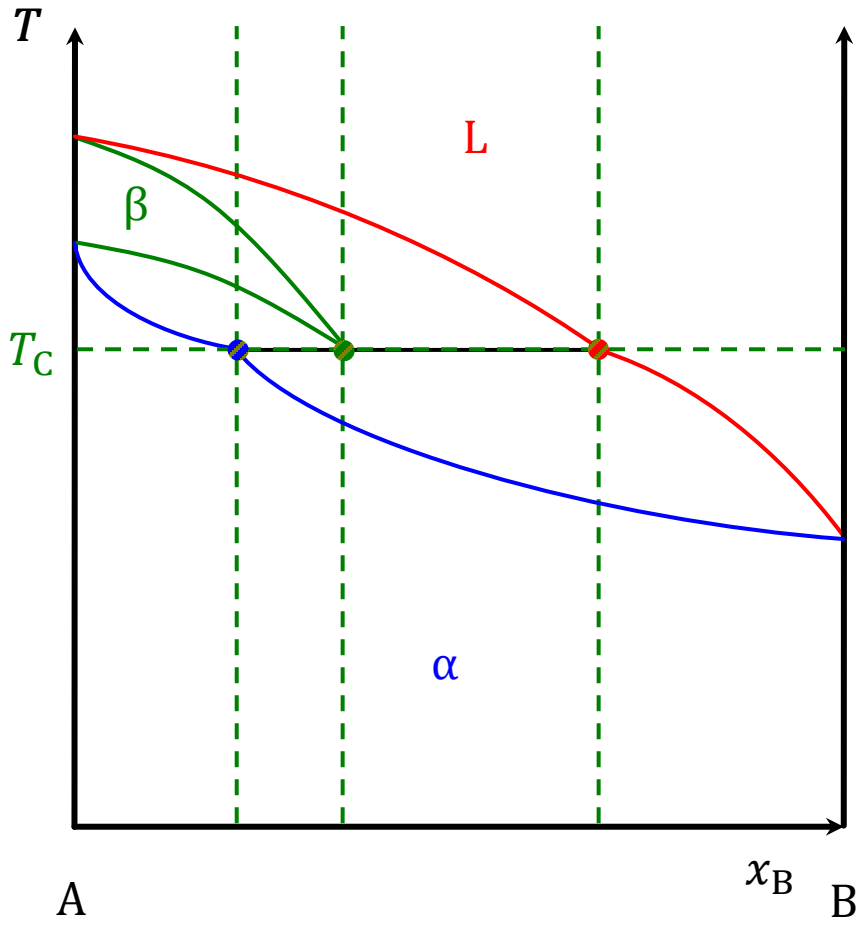


The essential difference to the peritectic reaction is the relative change of the G curve as a function of T.



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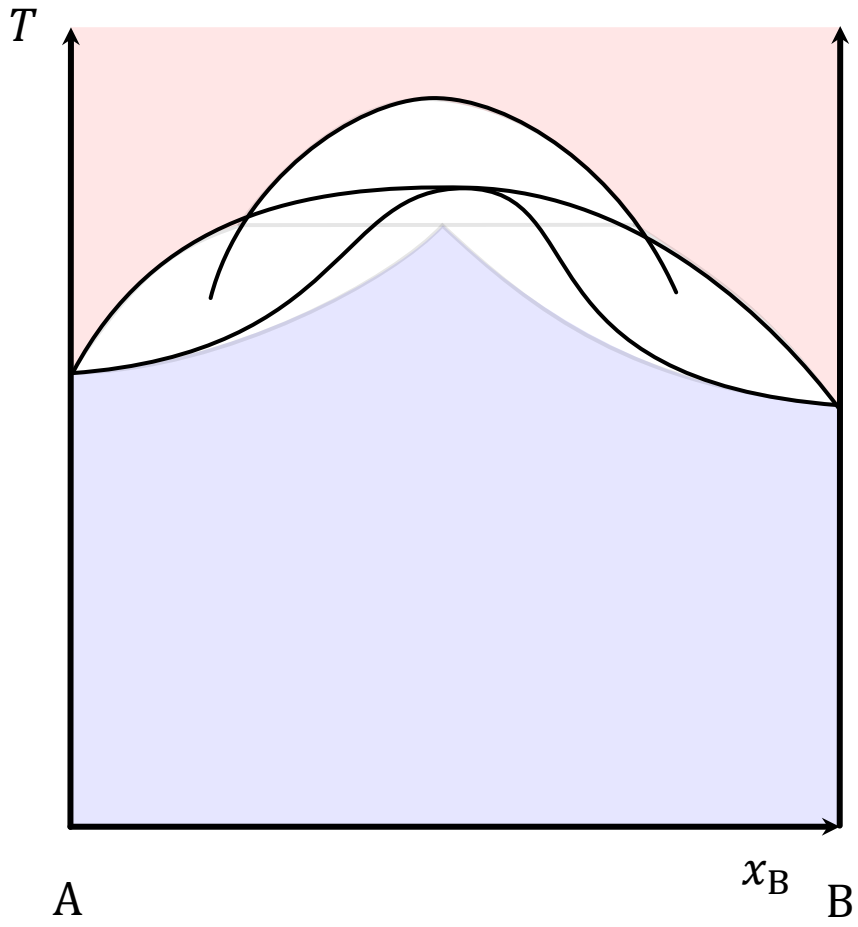

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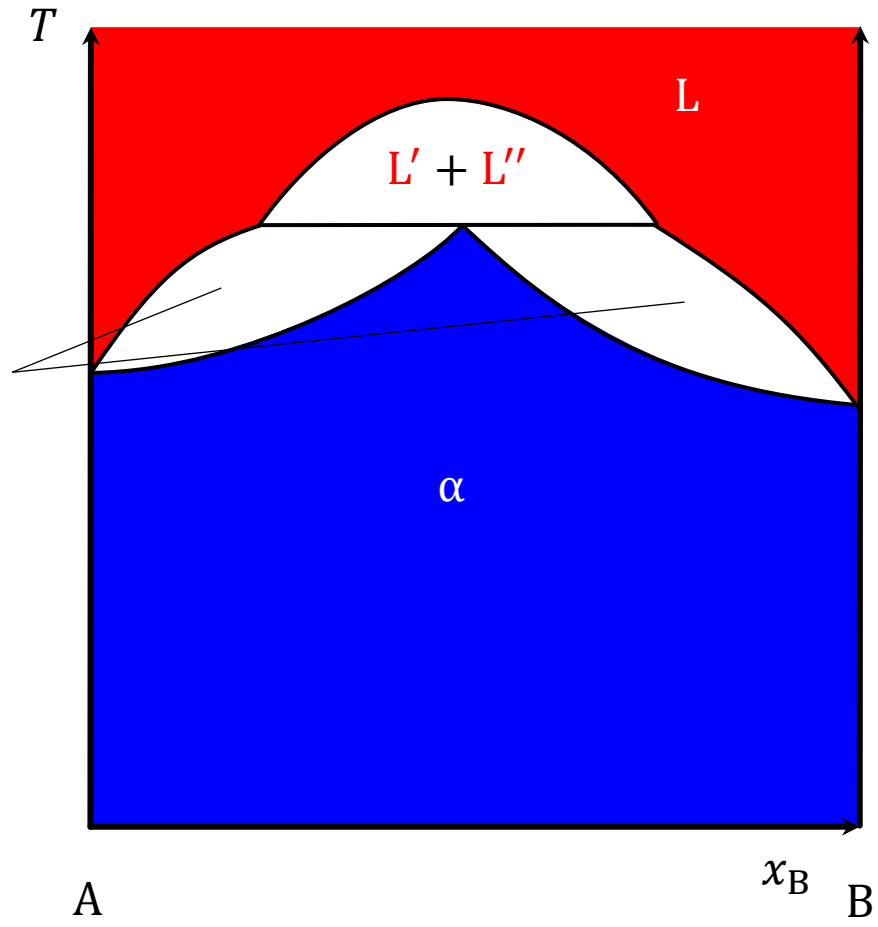
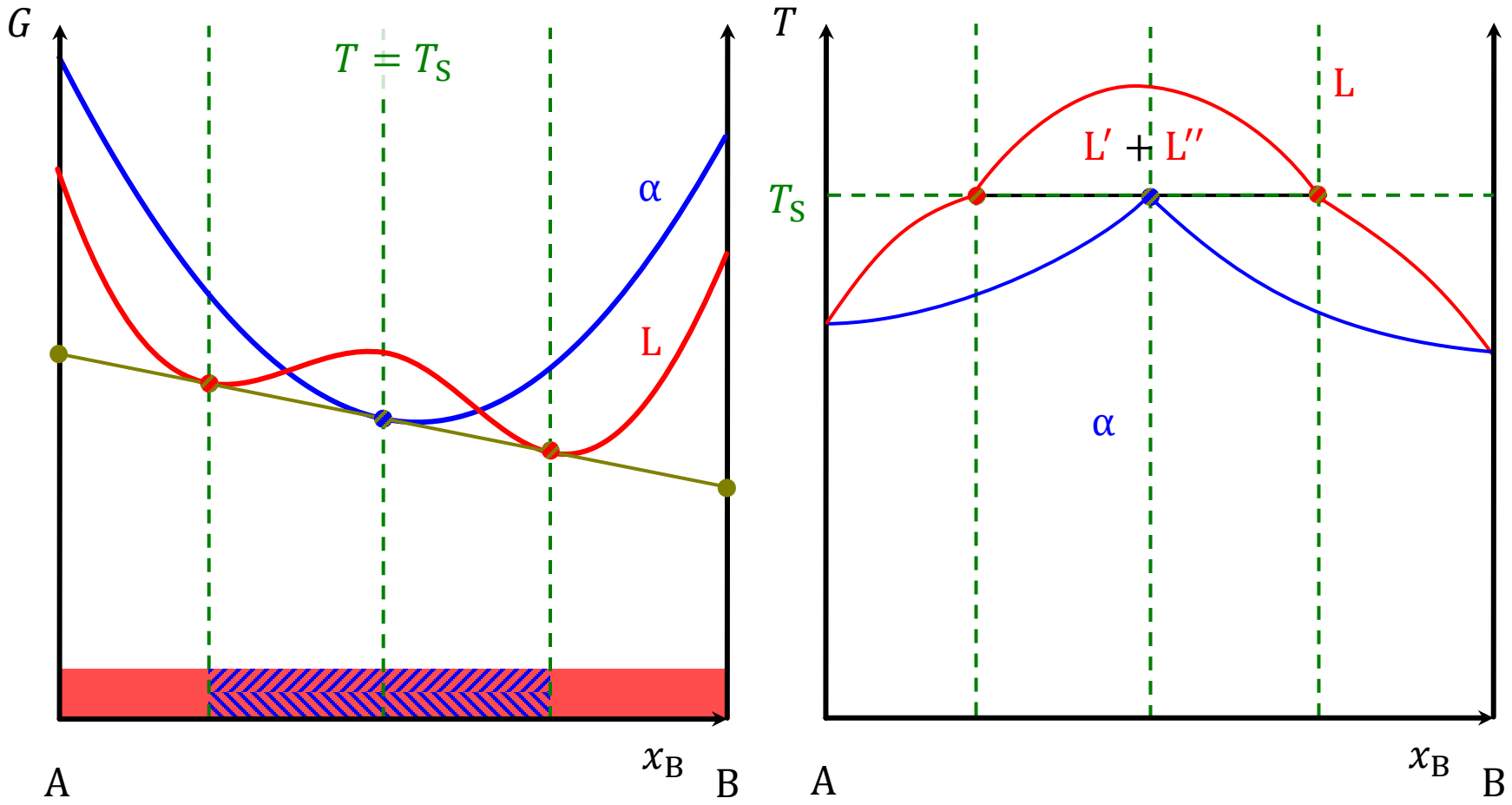
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