Phase Transformations: Solidification
Today’s topics:

- Solidification of superheated liquid against a cooled mold wall
- Solidification of supercooled liquid by a nucleation event in the liquid
- Shape stability of the solid/liquid interface
- Constitutional supercooling of an alloy
- Casting microstructures
Solidification of superheated liquid

- Heat removed through mold wall at $T < T_m$

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- Interface *stable* with respect to shape variations

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Solidification of supercooled liquid

- Latent heat removed into liquid at \( T < T_m \)

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- Interface *unstable* with respect to shape variations

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Constitutional supercooling in alloys

- Solute enrichment ahead of an advancing solid/liquid interface can effectively supercool the adjacent liquid by forming liquid compositions that are below their melting temperature. This commonly results in dendrite formation in alloys.

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Cells and dendrites

Features resulting from shape instability

**Cells & Dendrites**

$\sim 10 \mu m$

Macro grain structure of a casting

$\sim 0.1 - 10 \text{ mm grains}$

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SEM View of Dendrites in Cu–Ni–Mn Alloy

These dendrites are very large because the liquid metal was cooled very slowly.

When a material solidifies dendritically and forms a polycrystal, the grain size is generally much larger than the dendrite spacing.

Alloy solidification via dendrite formation leads to compositionally inhomogeneous material.

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Microsegregation

- Alloy solidification via dendrite formation leads to compositionally inhomogeneous material.

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