

VTO Materials Technologies Lightweight Materials Core Program Annual Review

Sarah Kleinbaum, Program Manager

Materials Technologies Program
Vehicle Technologies Office

David Gotthold

Pacific Northwest National Laboratory



Timeline

- Lab Call Award – September 2020
- Kickoff – November 2020
- End – September 2023
- 5% Percent complete

Budget

- Total project funding \$15M/3 years
- Funding for FY 2021 - \$5M

| | # of Projects | FY20201 Funding |
|---------------------|---------------|-----------------|
| Thrust 1 – Sheet Al | 3 | \$1,375,000 |
| Thrust 2 – Cast Al | 3 | \$1,450,000 |
| Thrust 3 – Cast Mg | 2 | \$1,175,000 |
| Crosscutting | 7 | \$1,000,000 |

Barriers and Technical Targets

- **Materials Performance and Cost** limit the penetration of lightweight Al and Mg alloys into the entire range of vehicle
- **New Alloy** development is slow and costly
- **Recyclability** is complex due to large number of different alloys

Partners

- Program Lead
 - Pacific Northwest National Laboratory
- Partner Laboratories
 - Oak Ridge National Laboratory
 - Argonne National Laboratory
- Industry Engagement
 - Informal support and guidance from OEMS and Tier 1 suppliers
 - CRADAs planned for future years

Materials Program Structure

- **Core Programs**
 - Composites Core Program
 - Multi-Material Joining Core Program
 - **Lightweight Metals Core Program**
 - Powertrain Materials Core Program
- **Strategic Activities**
 - Annual Funding Opportunity Announcements
 - 3-4 year projects rotating between the Core Program activities
- **Small Business Opportunities**
 - Annual Opportunities with multiple topics
 - 1-2 year projects, with opportunities for second phase funding

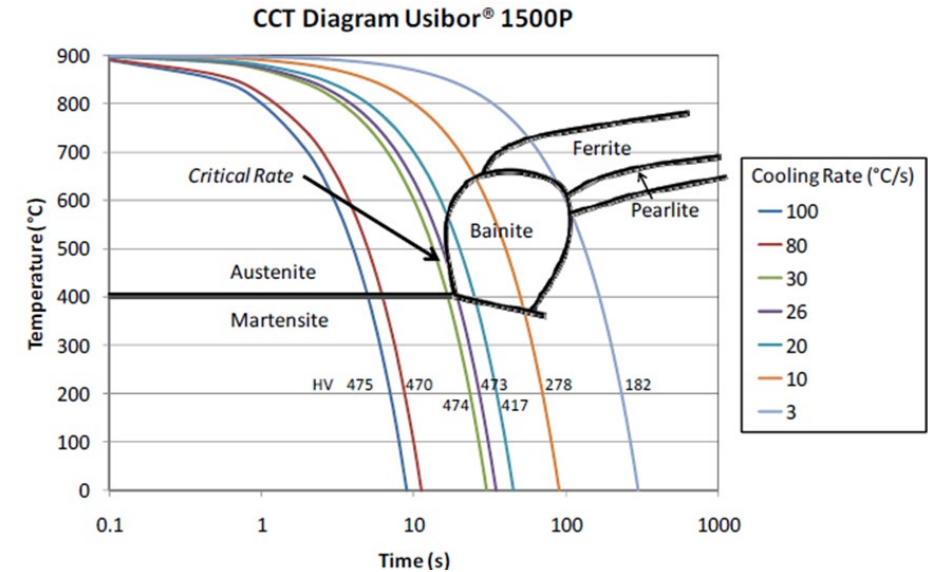
LMCP – Intentionally Heterogeneous Materials

Combine multi-scale modeling, rapid measurement of properties (high throughput testing) and novel processing technologies (solid phase processing, additive manufacturing and high intensity thermal treatment) to locally control material properties.

- **Focus on getting the right **properties** in the right place by intentional control of heterogeneous materials through:**
 - Deliberate local modification of microstructure and chemistry
 - Development of modeling approaches that can represent materials with heterogeneous behavior
- **Enables increased deployment of Mg and Al through:**
 - Deployment of proven alloys in high performance applications
 - Streamlined supply chain with fewer unique alloys
 - Reduced cost by only putting performance where needed
 - Simplified recycling, both during manufacturing and end of life

Put the right “property” in the right place

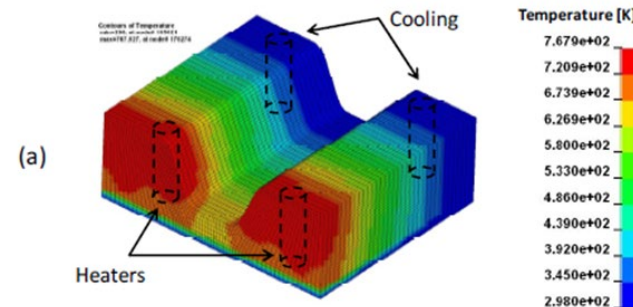
Selective processing is well known in the steel world



R. George, “Masters Thesis: Hot Forming of Boron Steels with Tailored Mechanical Properties Experiments and Numerical Simulations,” University of Waterloo, 2011.

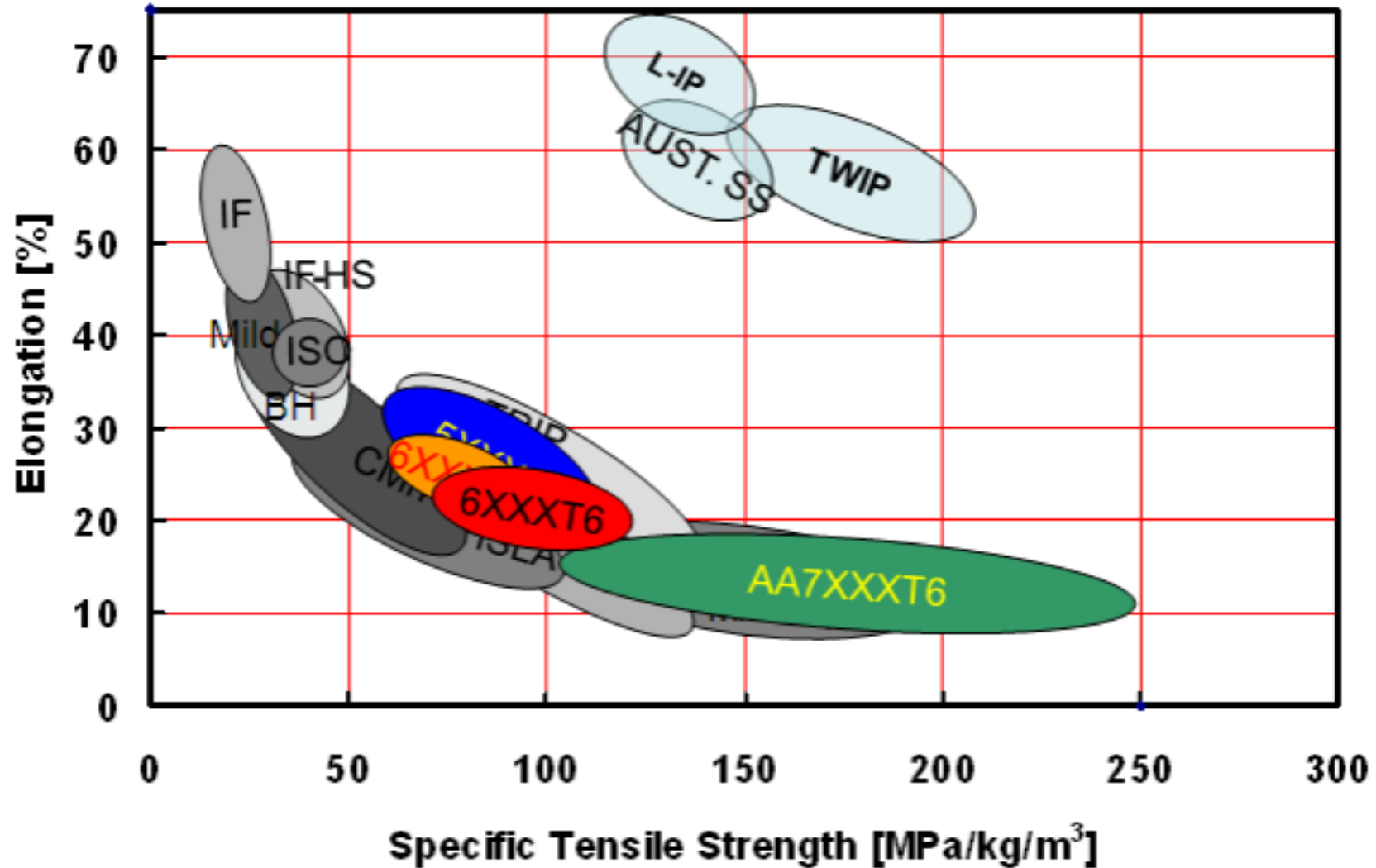


Honda Accord at the 2016 Great Designs in Steel Conference

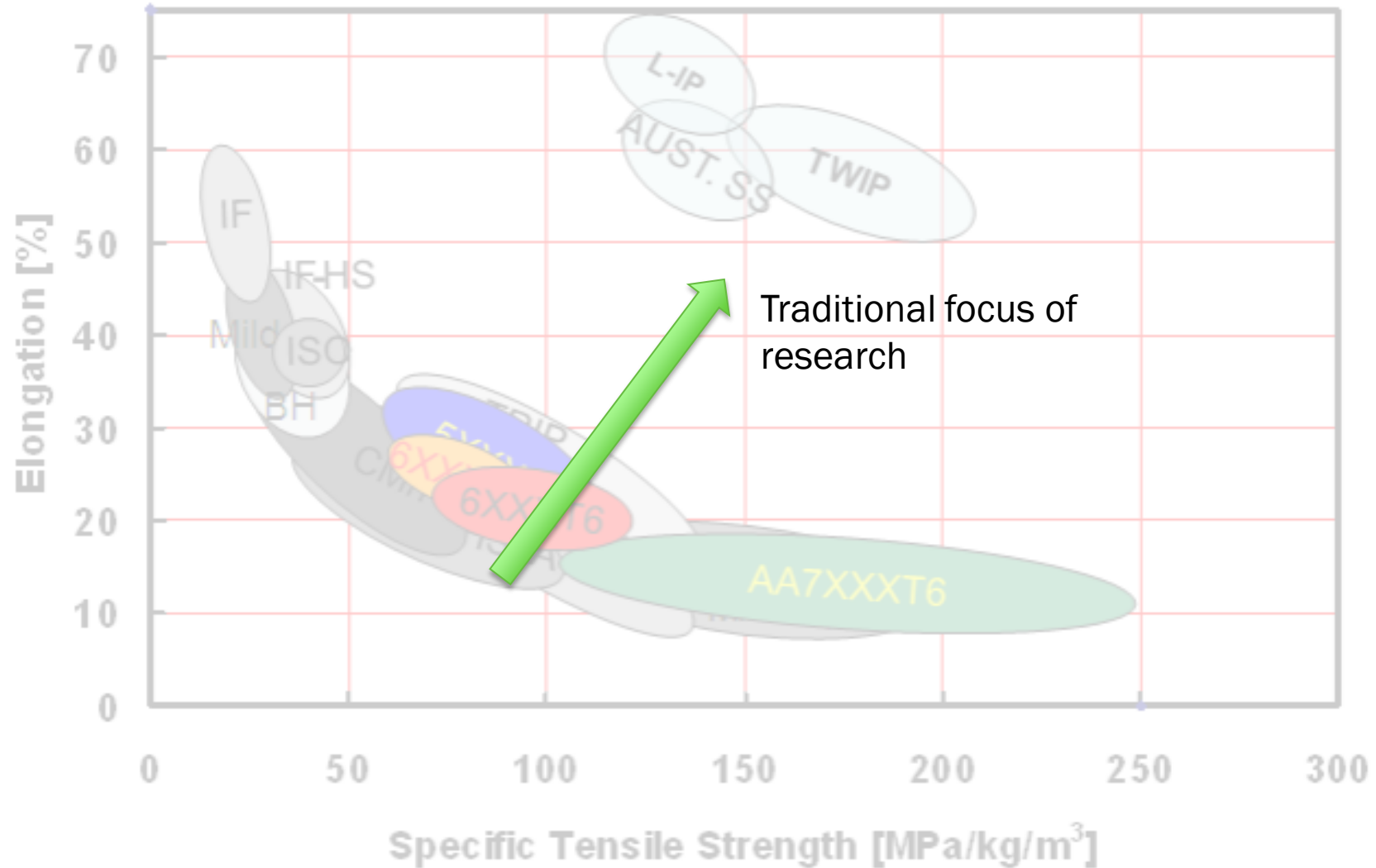


Is there an analog to these concepts for Aluminum and Magnesium ?

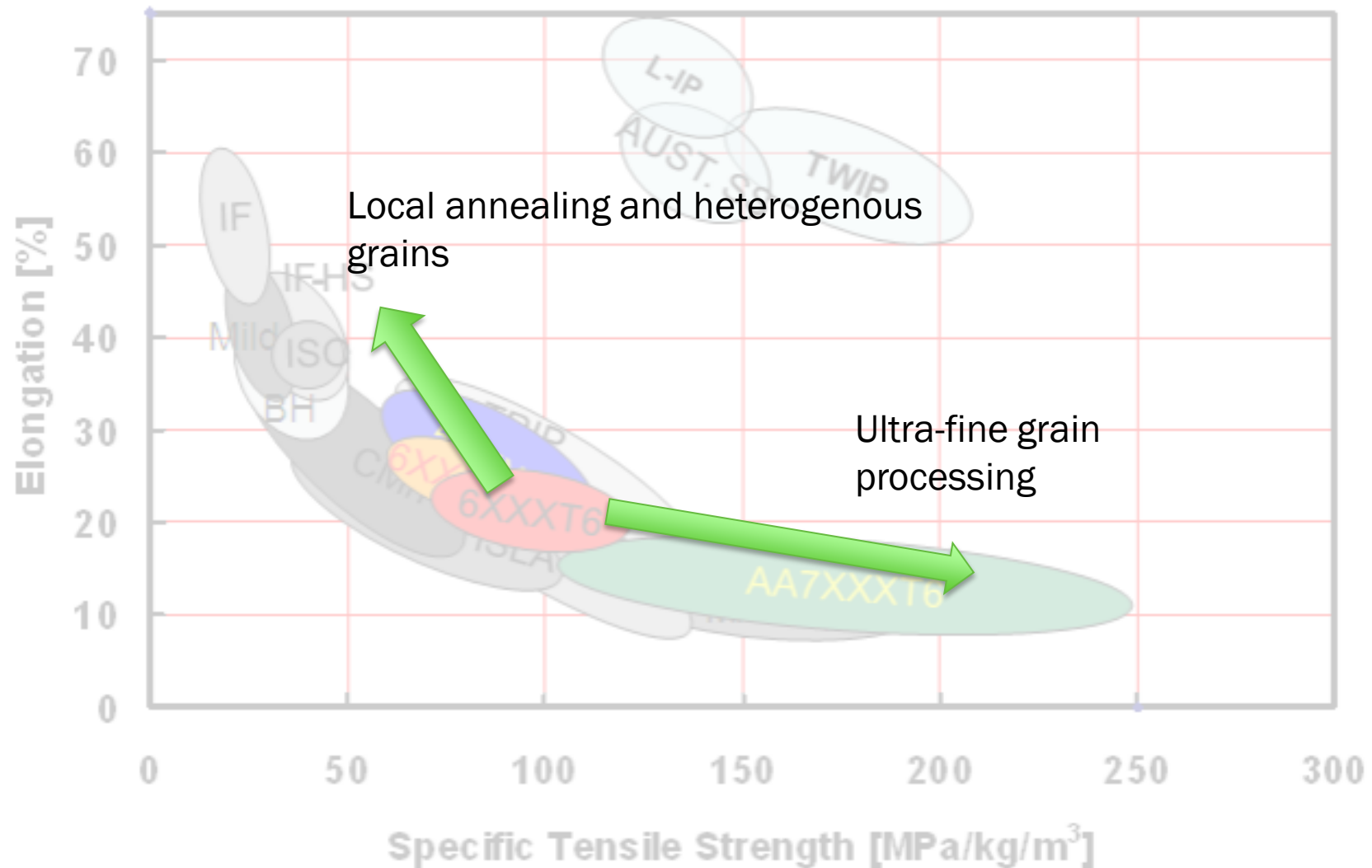
Traditional Banana Curve – Alloy Based



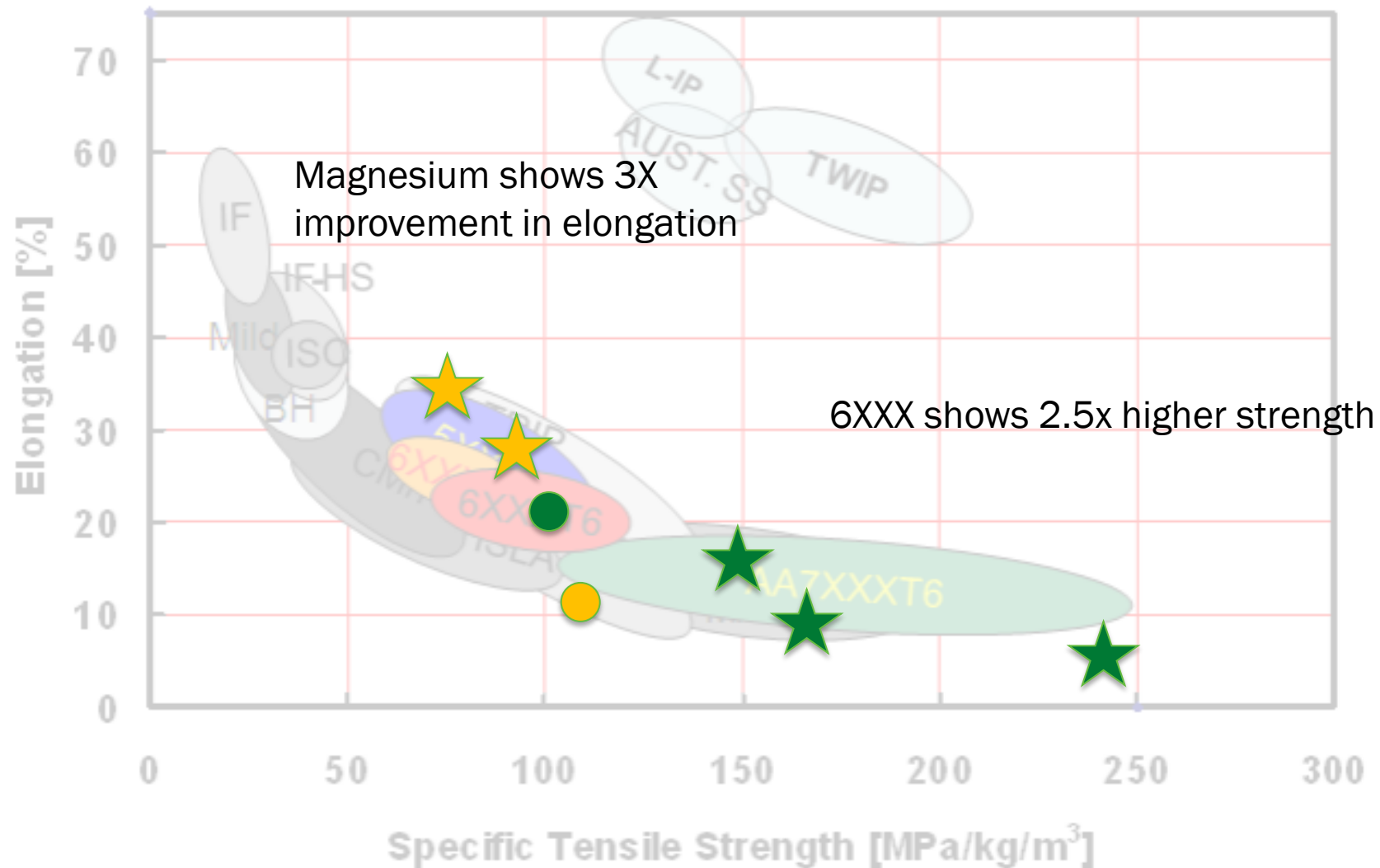
Traditional Approach – Improve Everything



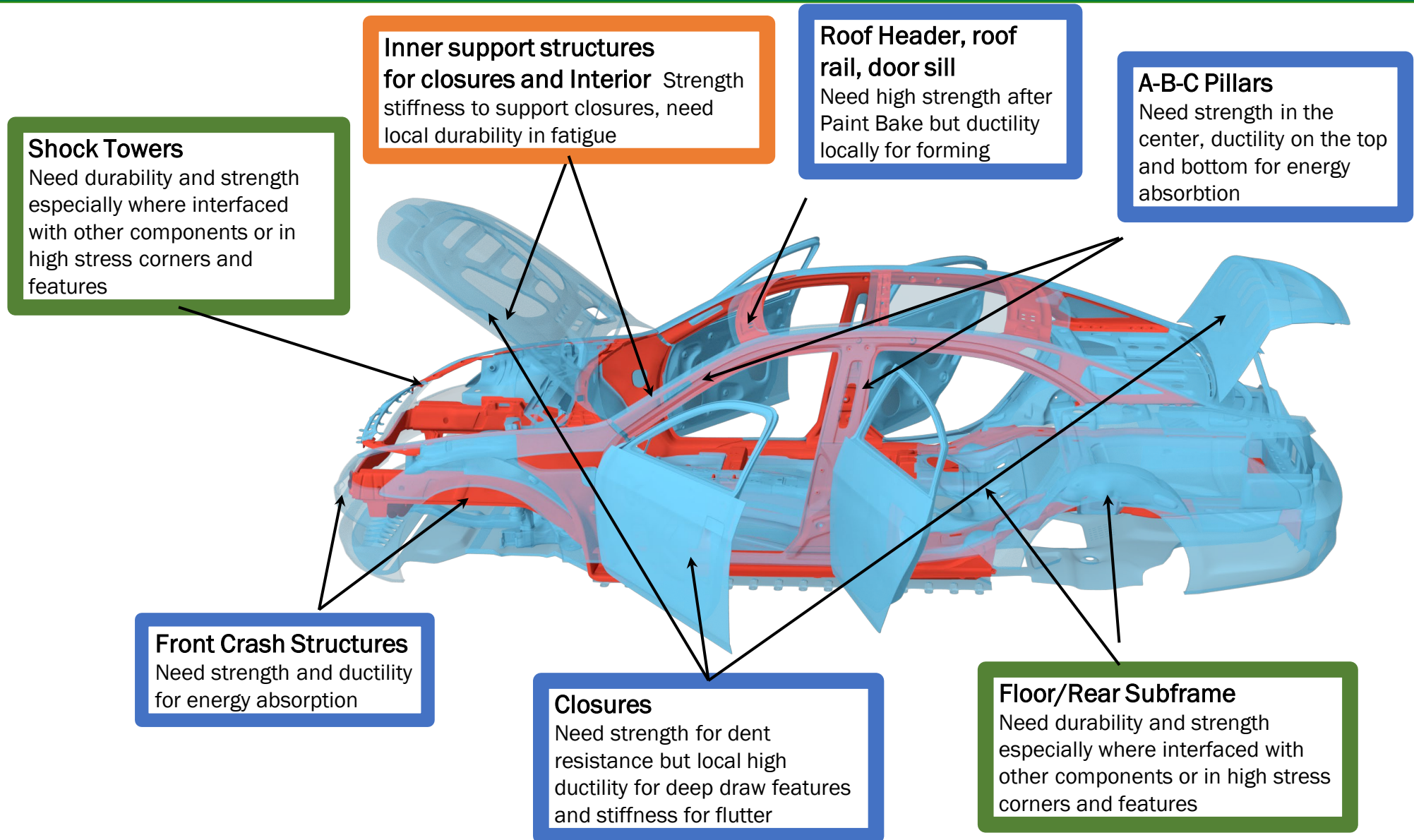
Proposed Research – Improve Where Needed



Novel thermomechanical processing

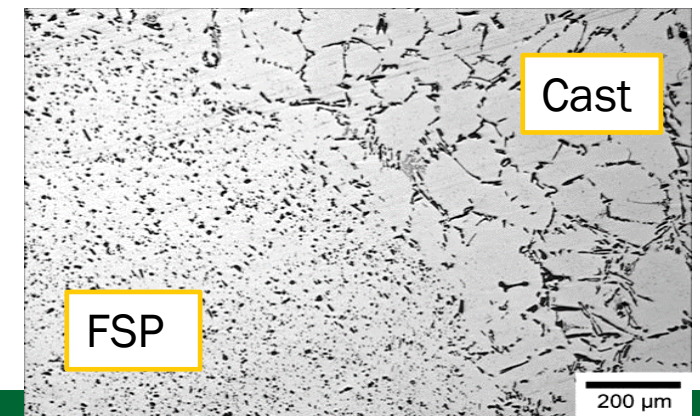
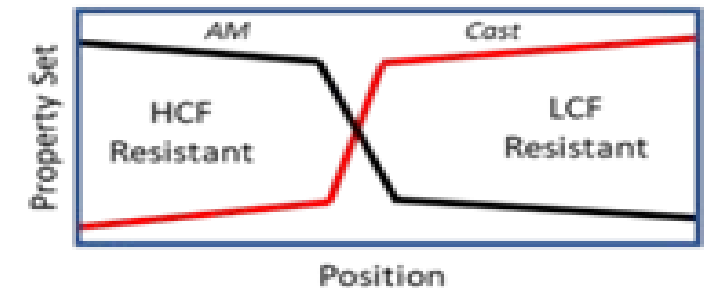
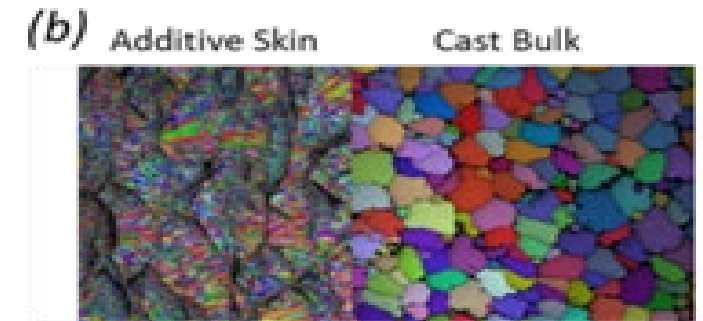
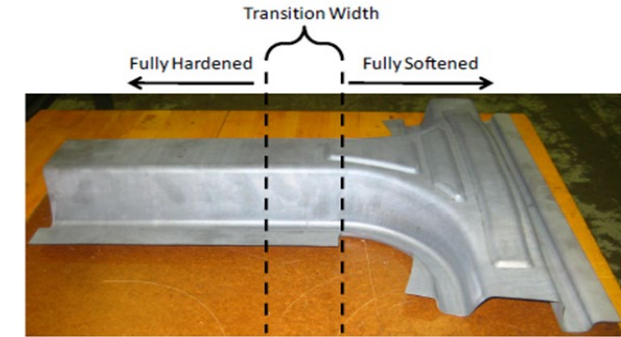


There are competing local requirements within single parts or assemblies



Key Scientific Questions

- How does microstructure and therefore properties, evolve through the processing route
- How are property gradients developed and controlled in the process
- How does the selective process influence the local properties such as later response to paint bake, and how does this influence the global performance
- How far can commercial materials be improved if processed far-from-equilibrium through high shear Solid Phase Processing, high intensity thermal treatments or through rapid solidification (AM)
- What is the fundamental understanding needed to make a process stable and robust so it can be transitioned to industry



LMCP Program Structure

Advanced Process Technologies: 1) Solid-Phase Processing, 2) Additive Manufacturing, 3) High-Intensity Thermal Treatments

Thrust 1
Localized Property Enhancements for Sheet Aluminum Applications

- Produce sheet with variable local properties, or processes locally modify formed sheet components to enhance properties in select regions for a component.
- Three (3) projects focused on methodologies to control sheet microstructure in 5000, 6000, 7000 series aluminum to tailor the right property in the right place.

Thrust 2
Localized Property Enhancements for Cast Structural Aluminum Applications

- Improve microstructures, and therefore properties, selectively applied and integrated with the fabrication process, and optimized for heat treatment.
- Three (3) projects aimed at creating wrought like microstructures and properties in local regions of aluminum-silicon castings.

Thrust 3
Localized Property Enhancements for Cast Magnesium Applications

- Develop local surface modifications to mitigate corrosion, and methodologies to modify the ductility, strength and creep performance of magnesium castings.
- Two (2) projects to that will enhance the integrity and durability of magnesium castings through localized microstructural improvements to surface properties.

Thrust 4: Characterization, Modeling, and Lifecycle

TRL-2
Technology
Concept

Accelerating Development of Advanced Lightweight Metals

TRL-4
Component
Validation

VTO Materials Technologies Lightweight Materials Core Program Annual Review

Sarah Kleinbaum, Program Manager

Materials Technologies Program
Vehicle Technologies Office

David Gotthold

Pacific Northwest National Laboratory

