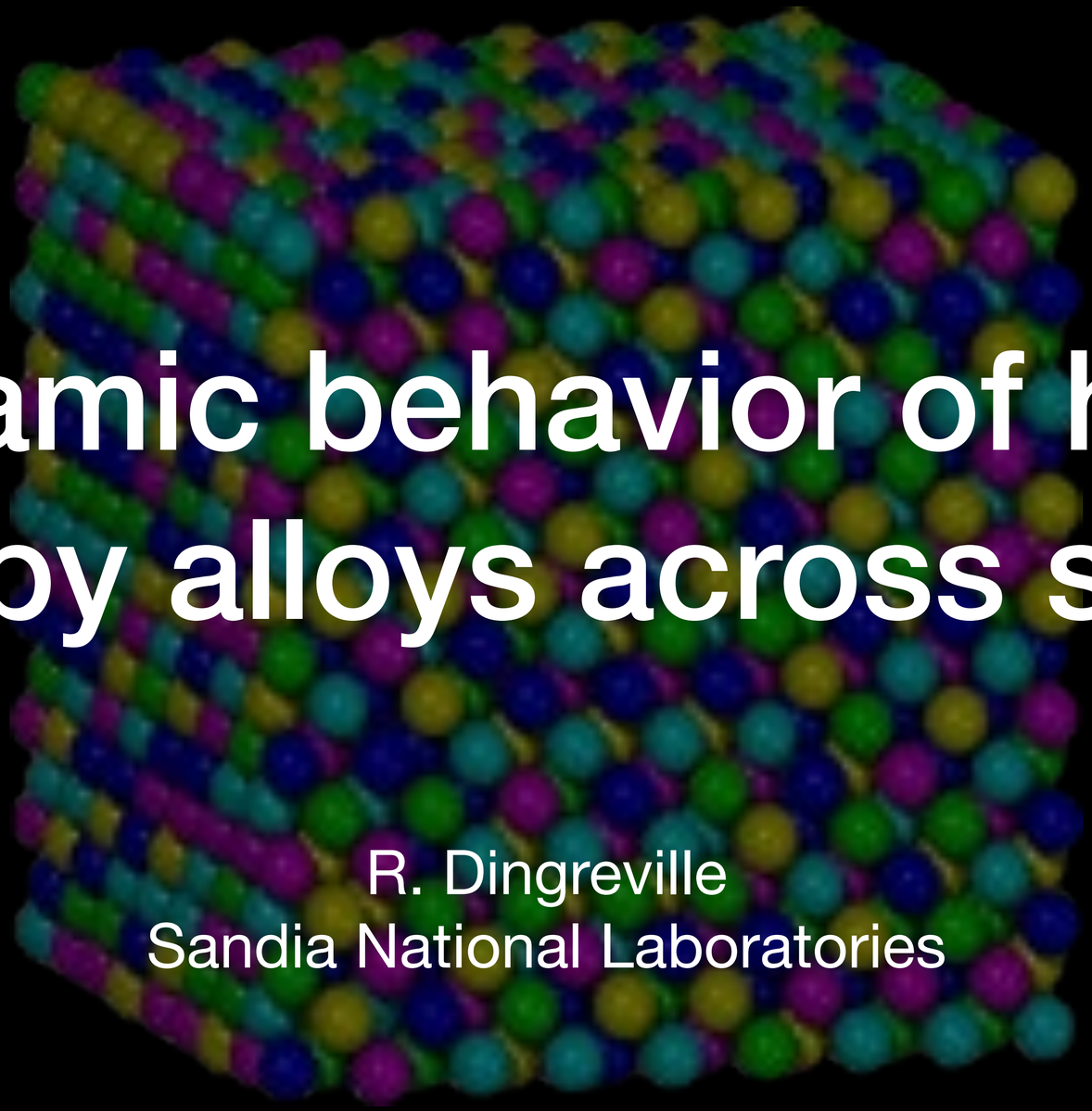
Exceptional service in the national interest



Dynamic behavior of high-entropy alloys across scales

R. Dingreville
Sandia National Laboratories

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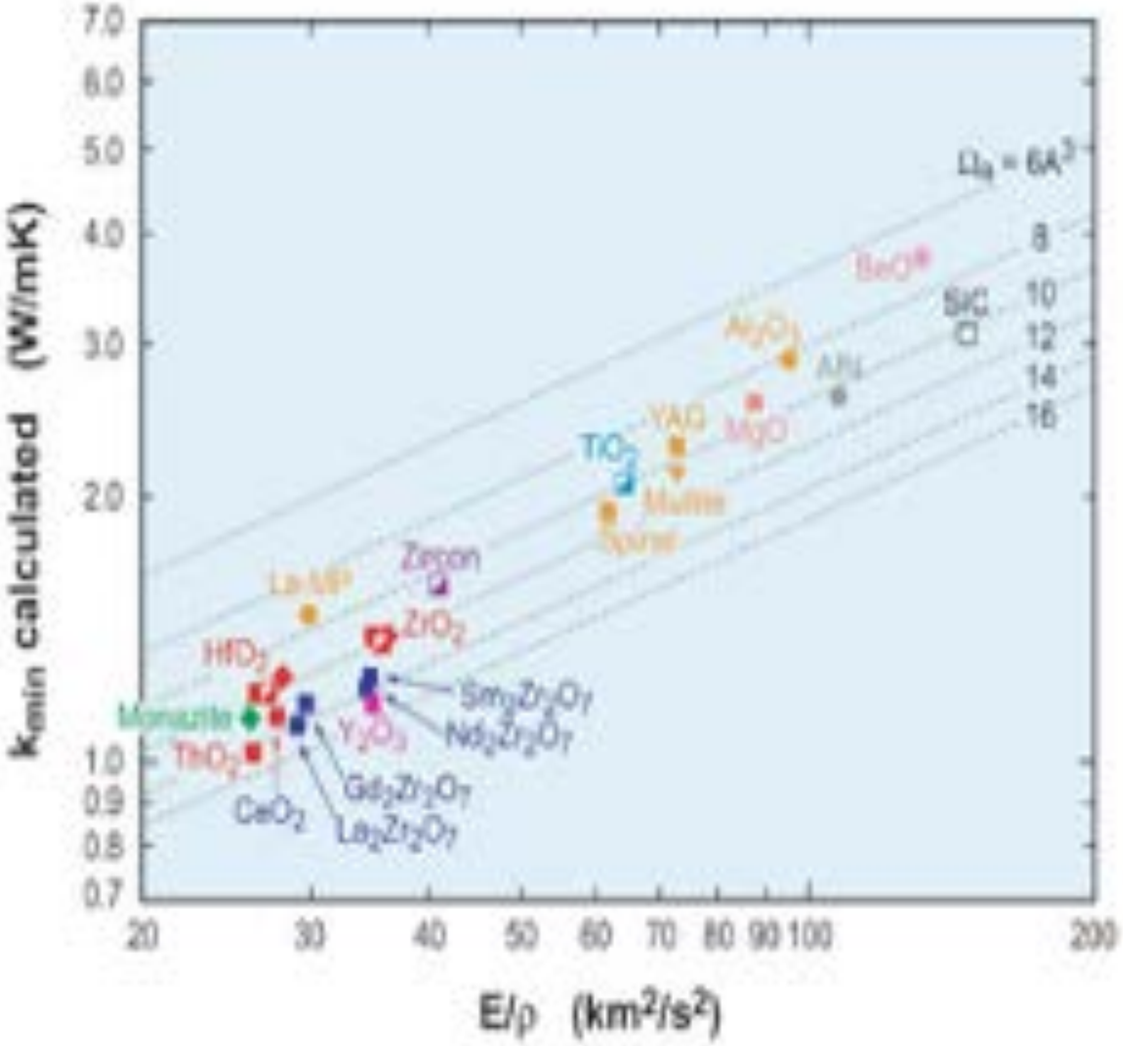
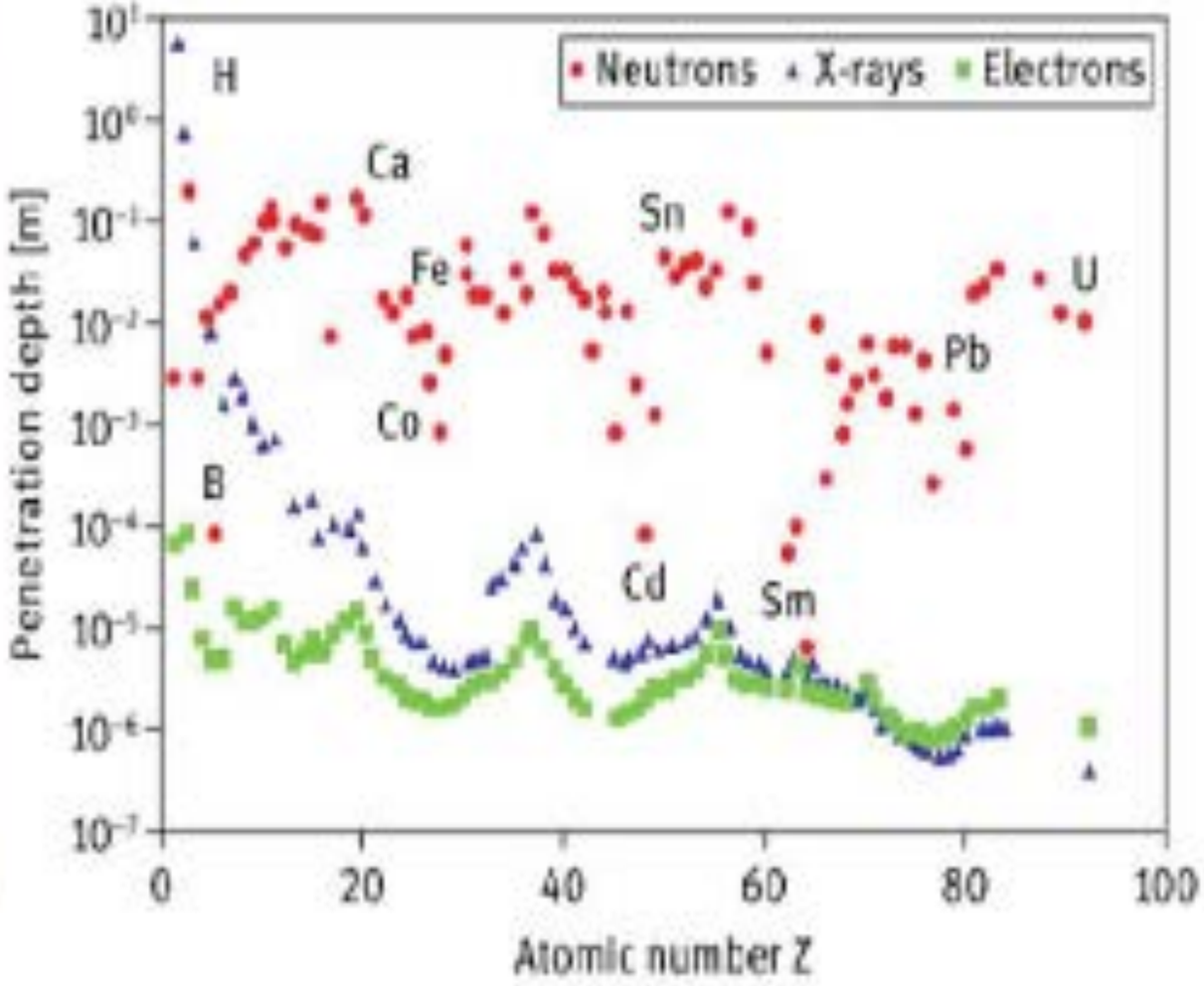
Challenges with Alloys Response in Complex Environments





High-Entropy Alloys As a Disruptive Metallurgical Approach

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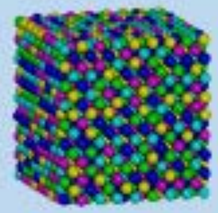
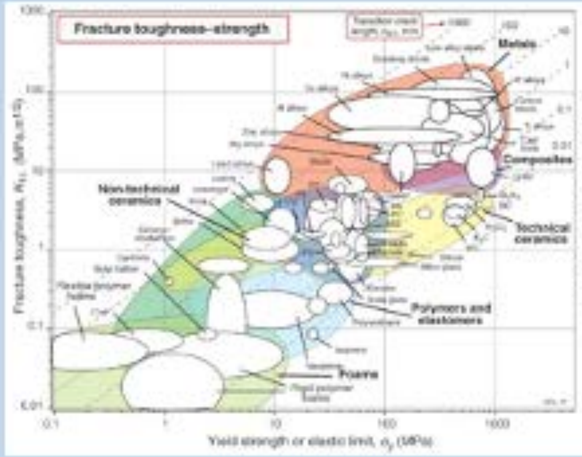
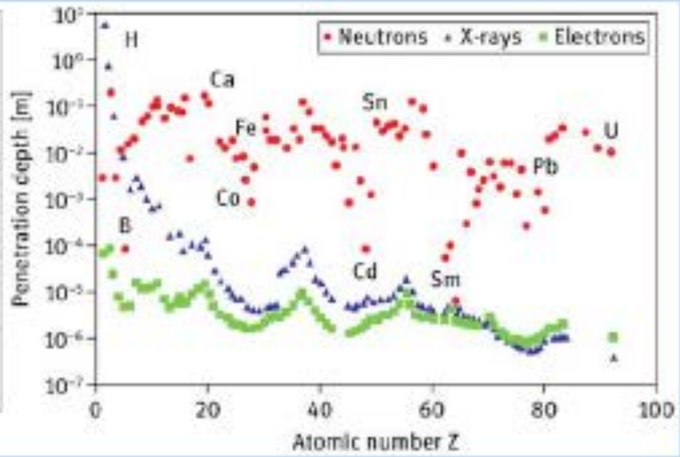
HEA composition can be chosen to partition and control energy deposition with robust thermo-mechical properties

HEAs



- Composed of multiple elements
- Role of configurational entropy
- Robust phase stability
- High temperature strength
- Radiation tolerance

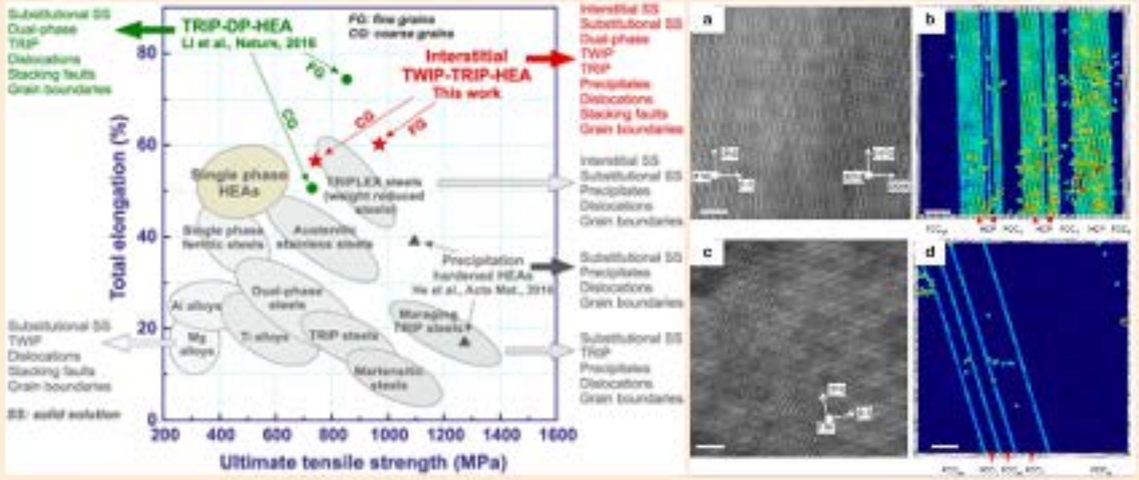




Compositional effects (local partitioning)

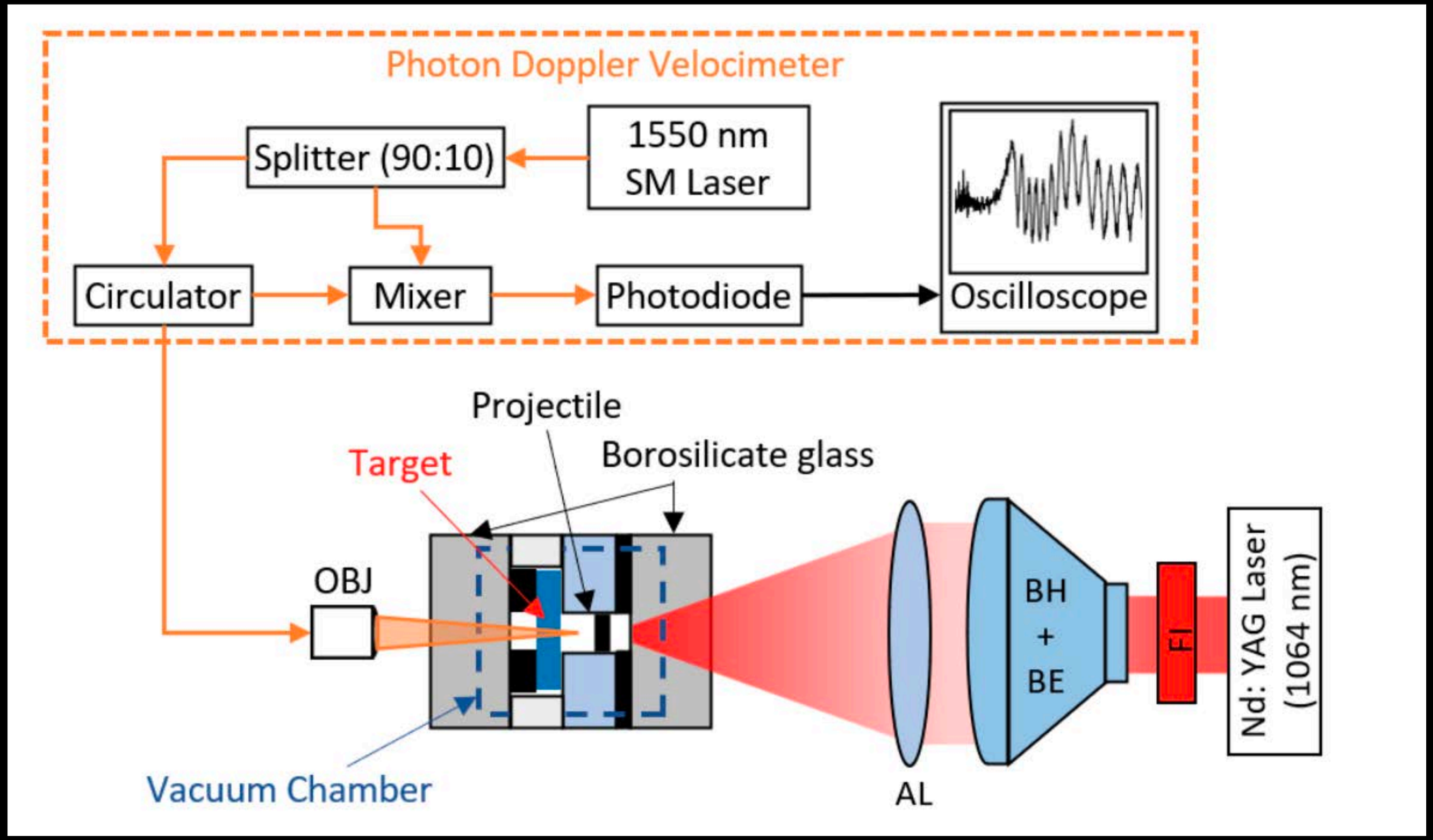
Metastability

- Thermodynamic "weakness" (i.e., lack of stability) triggers transformation
- Transformation-induced plasticity (TRIP/TWIP)
- Magnetic frustration
- Thermodynamically unpredicted phases

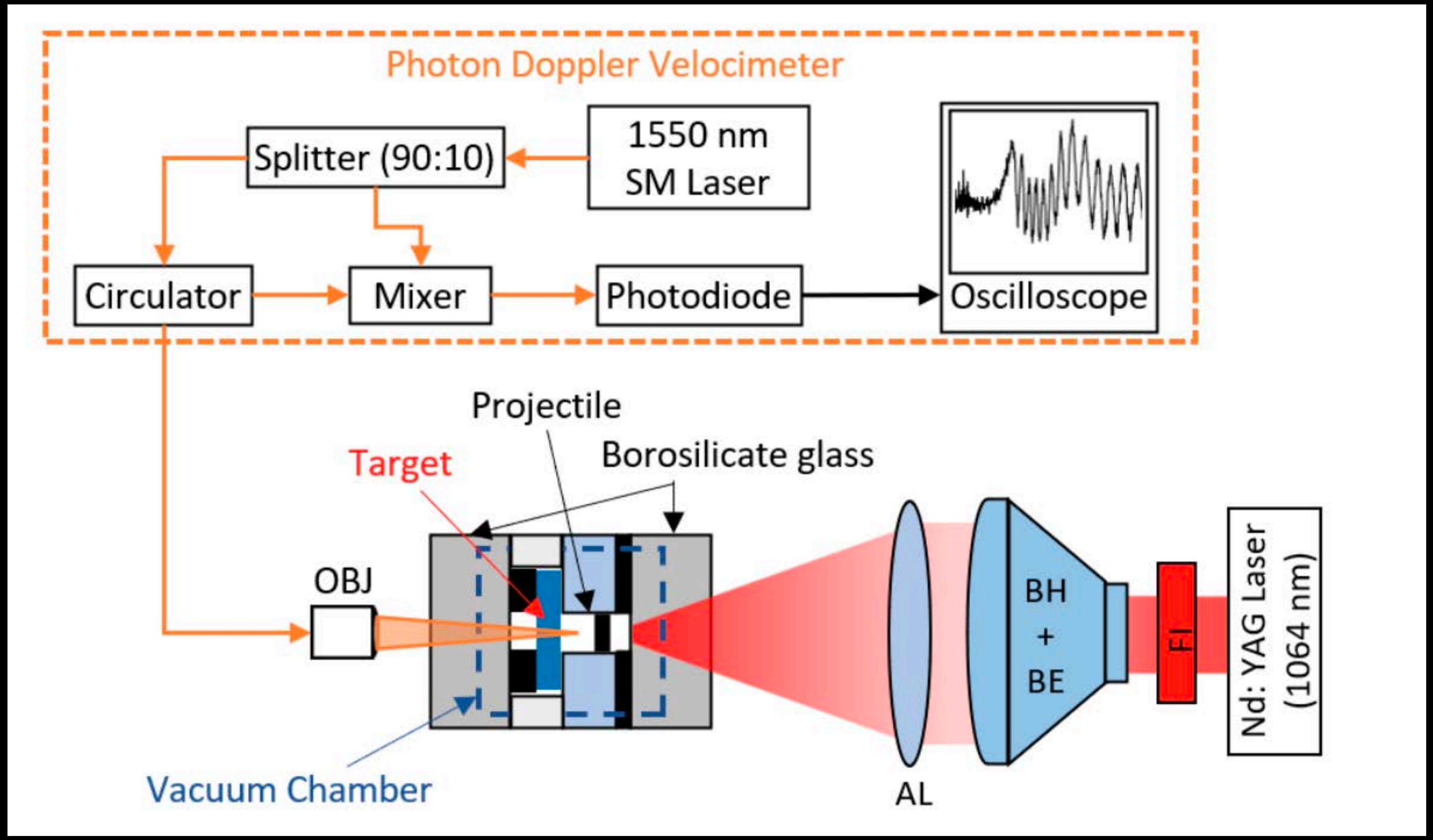


Embedded strengthening mechanisms

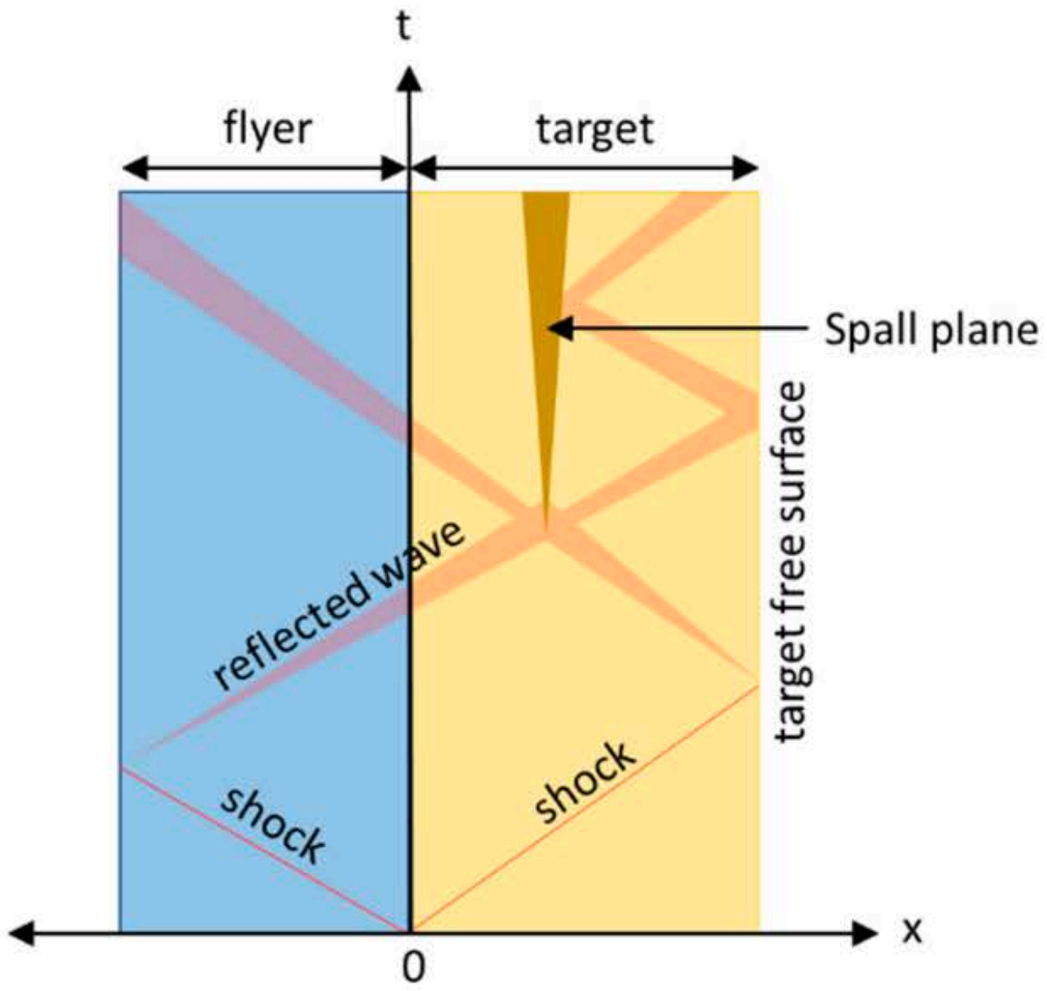
High-Entropy Alloys As a Disruptive Metallurgical Approach

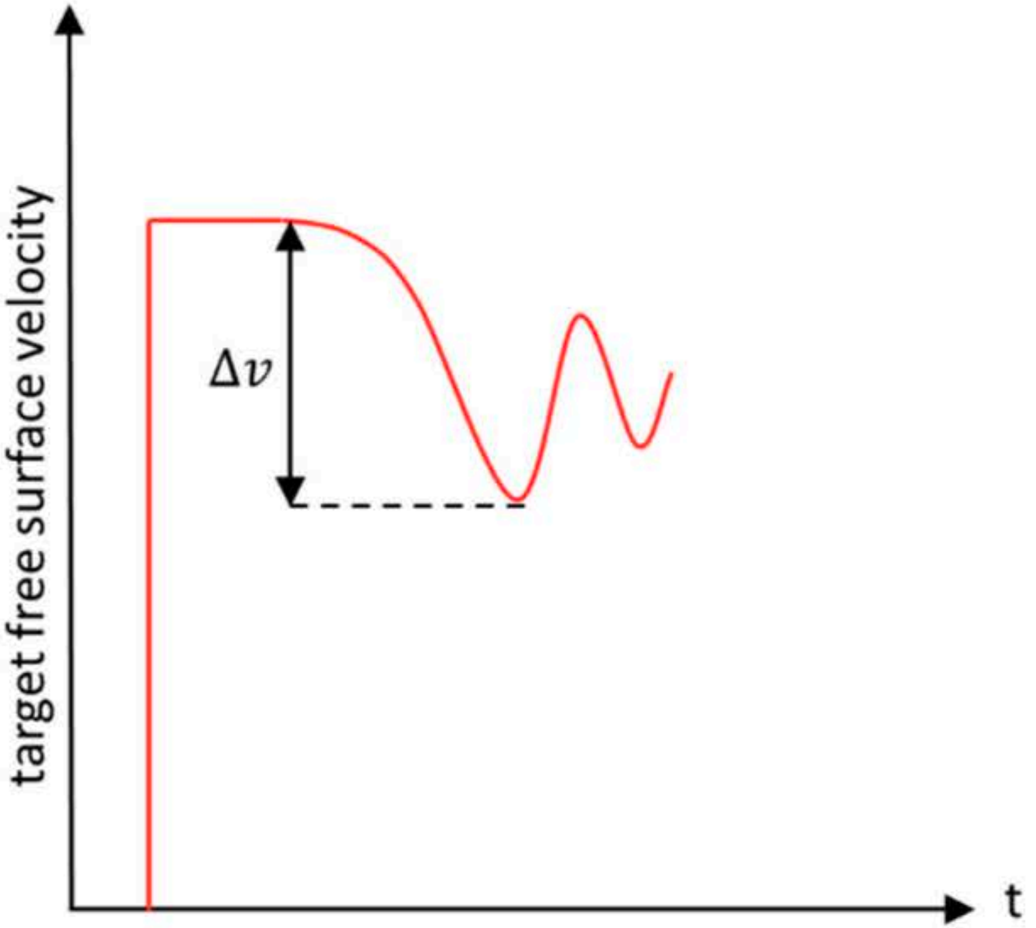


High-Entropy Alloys As a Disruptive Metallurgical Approach

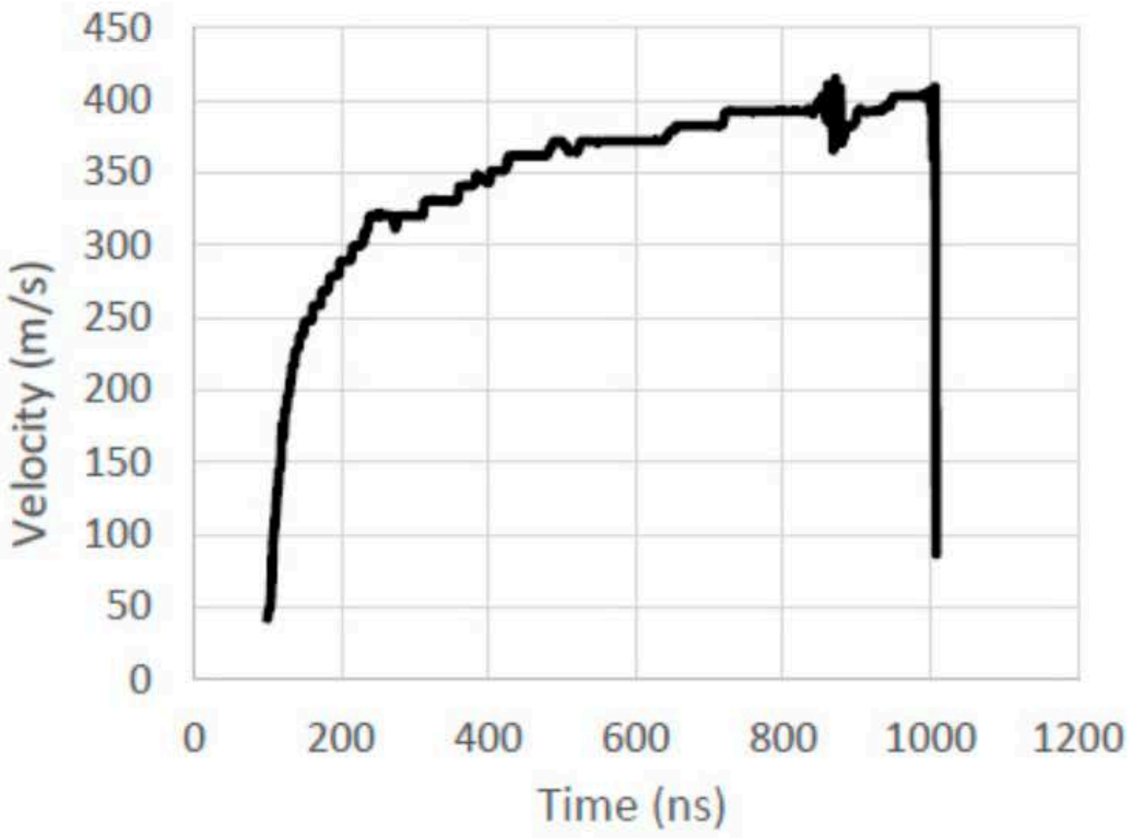


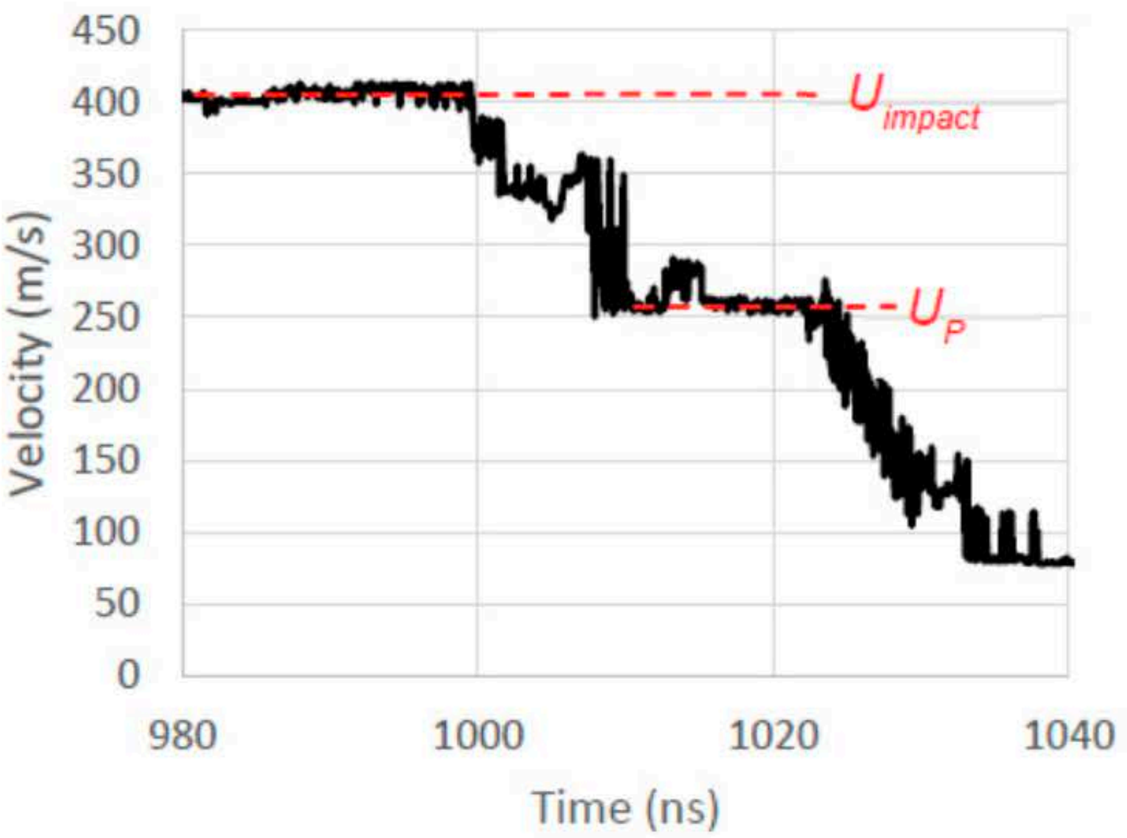
EXPECTED SPALL BEHAVIOR



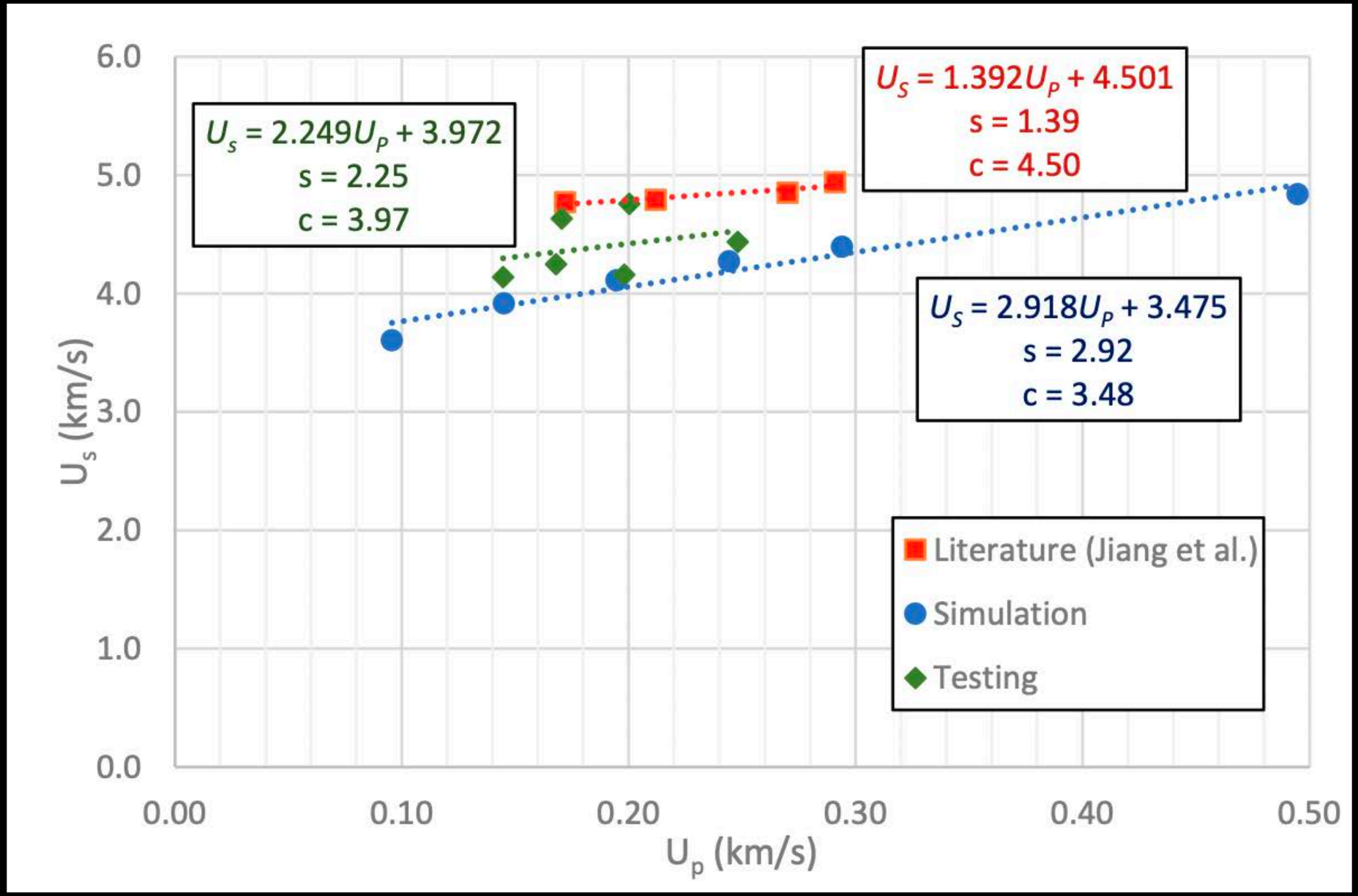


Spall Response

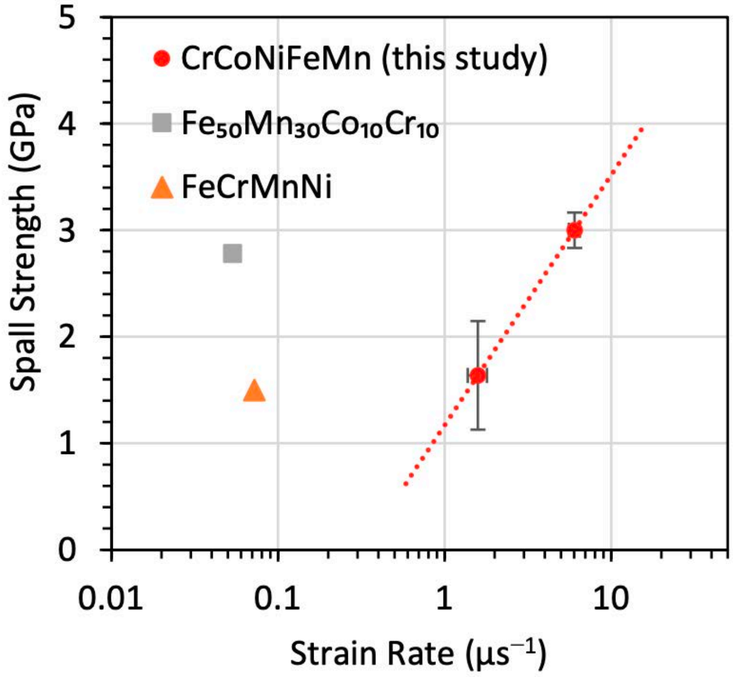


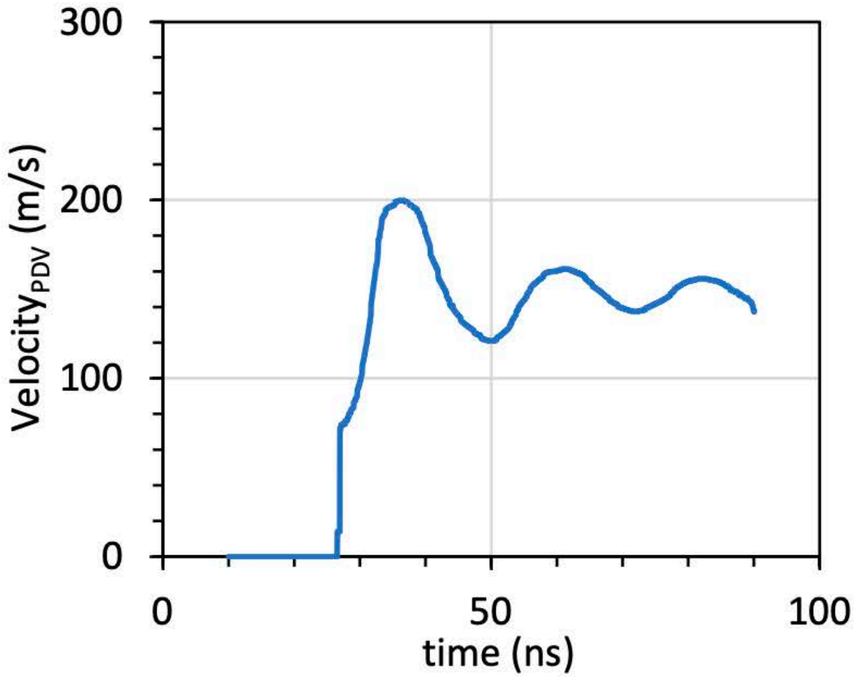


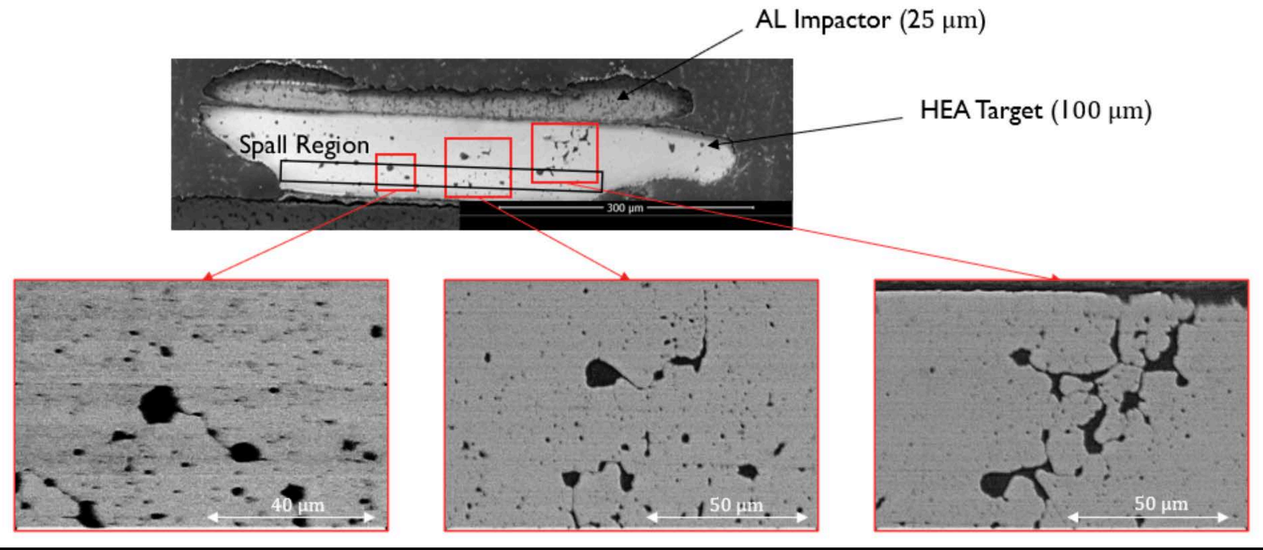
Spall Response



SPALL STRENGTH







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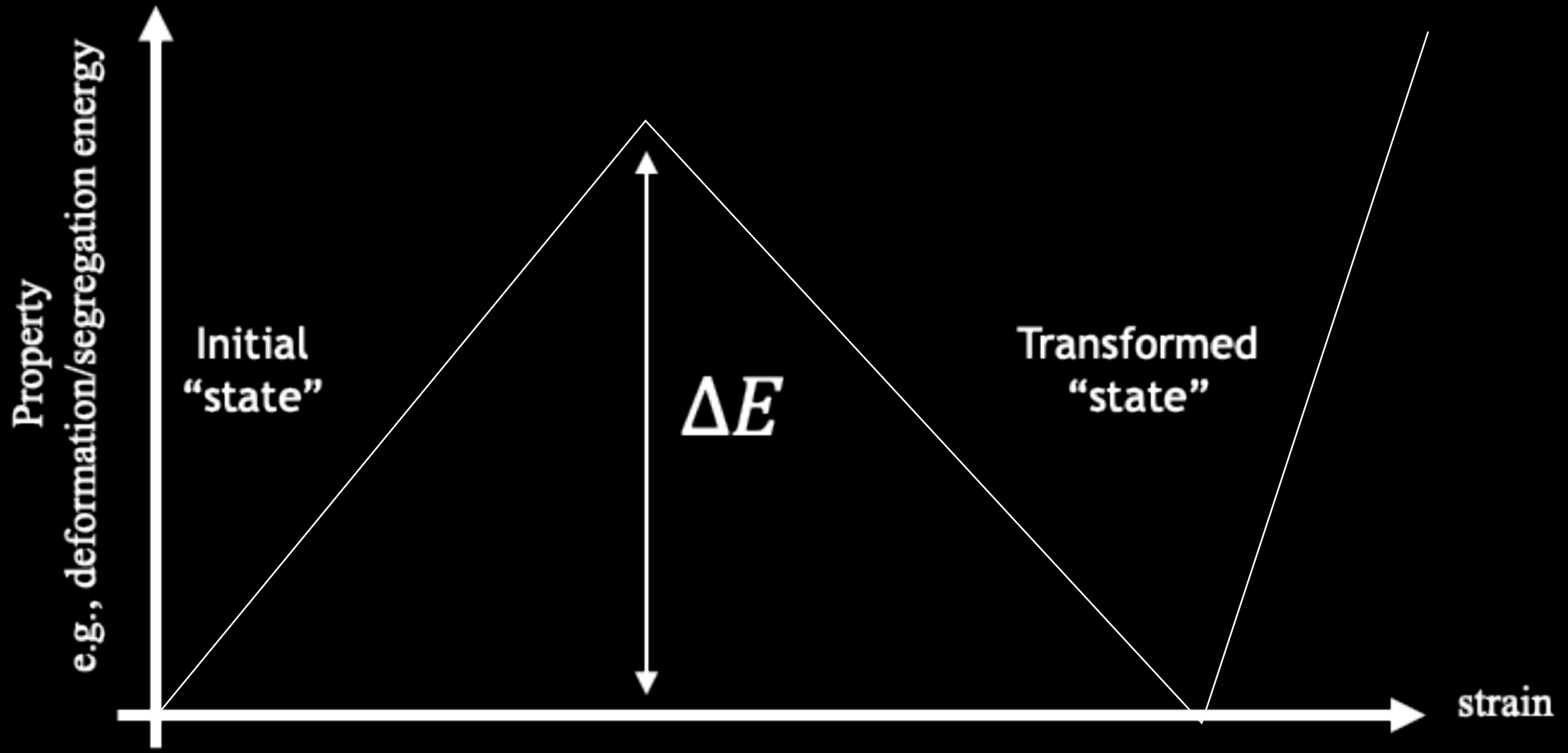
Are there Other Interesting Dissipative Mechanisms?

Transformation Barrier



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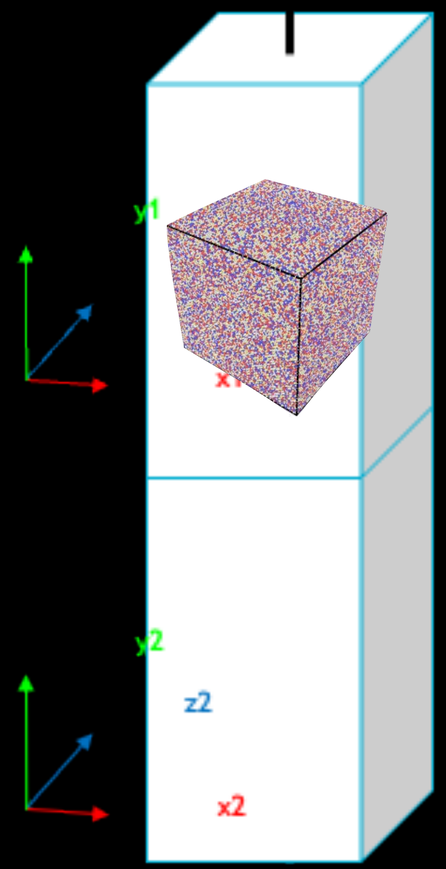
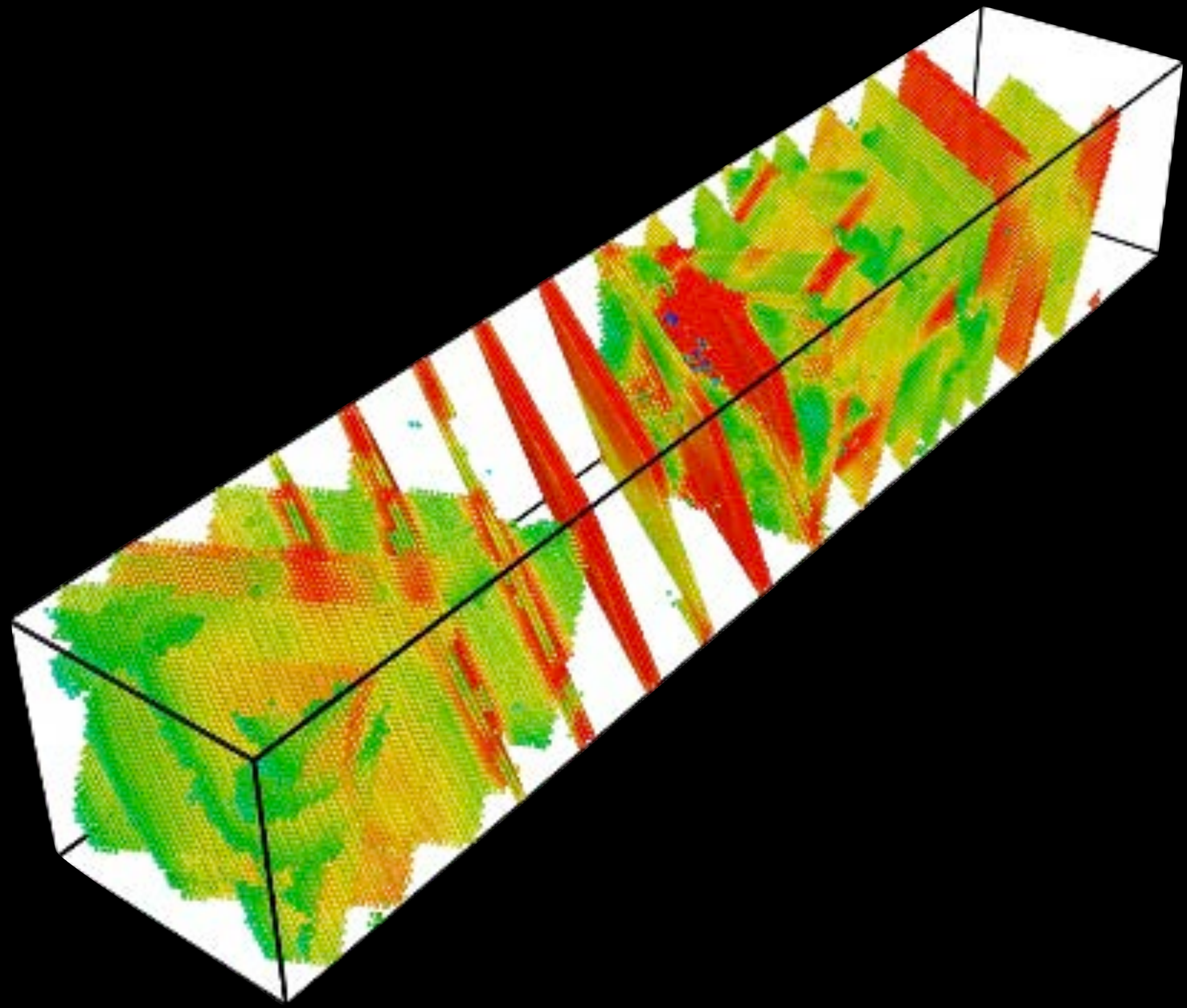
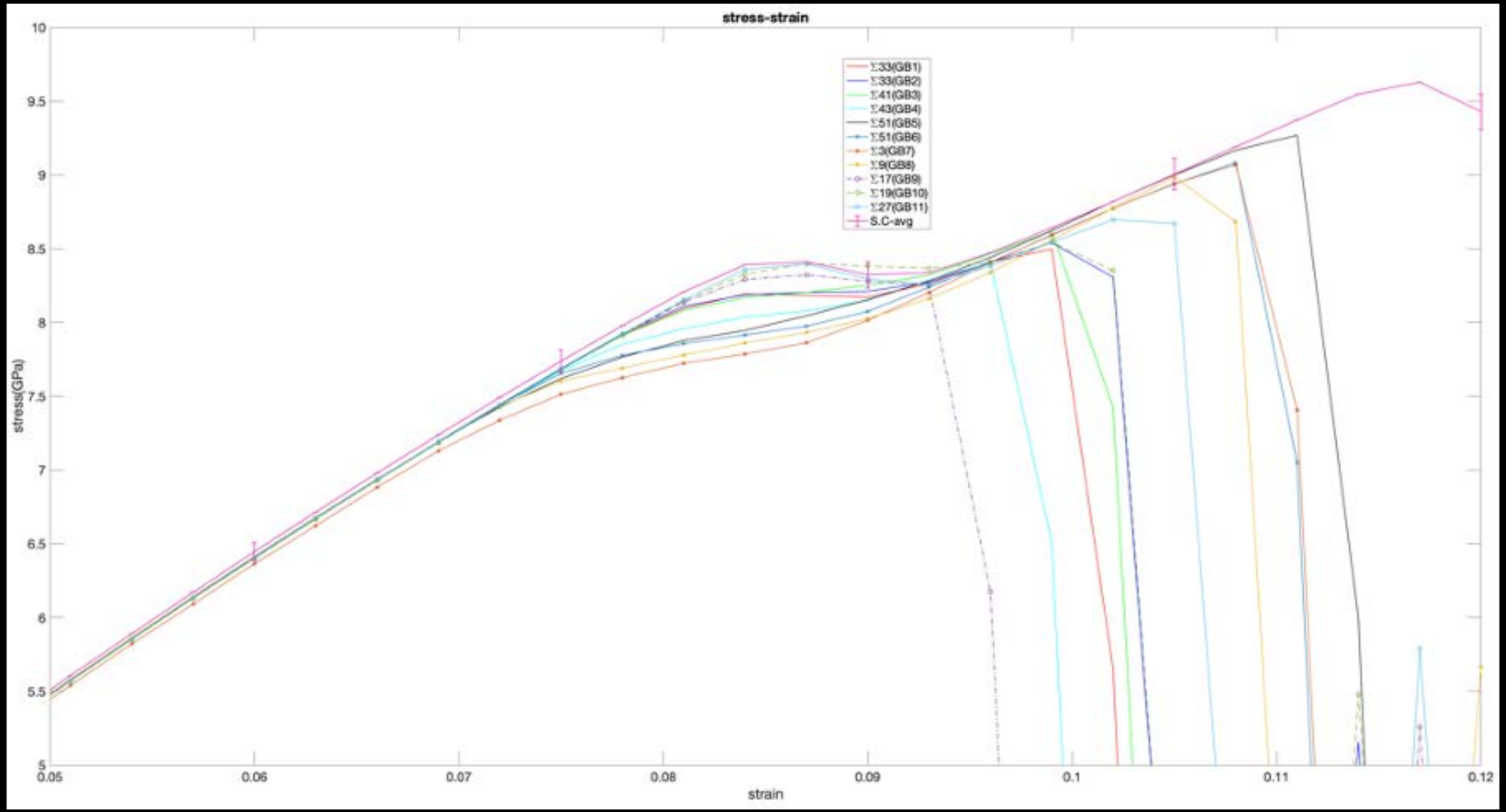




Twinning as a Phase Transformation…



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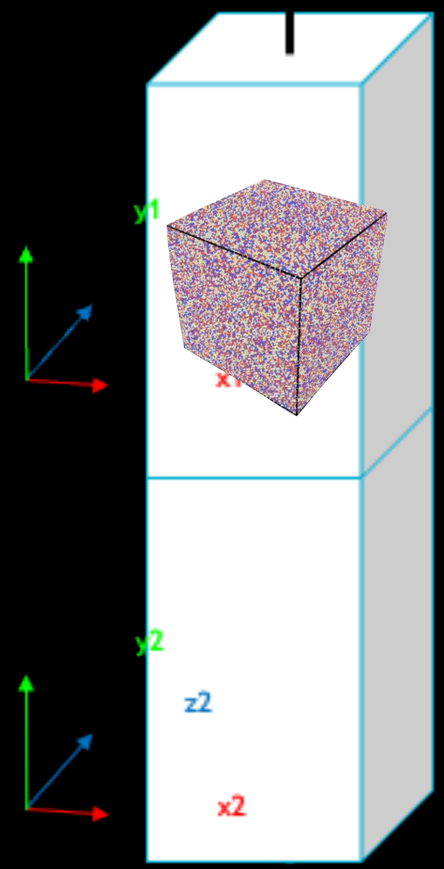
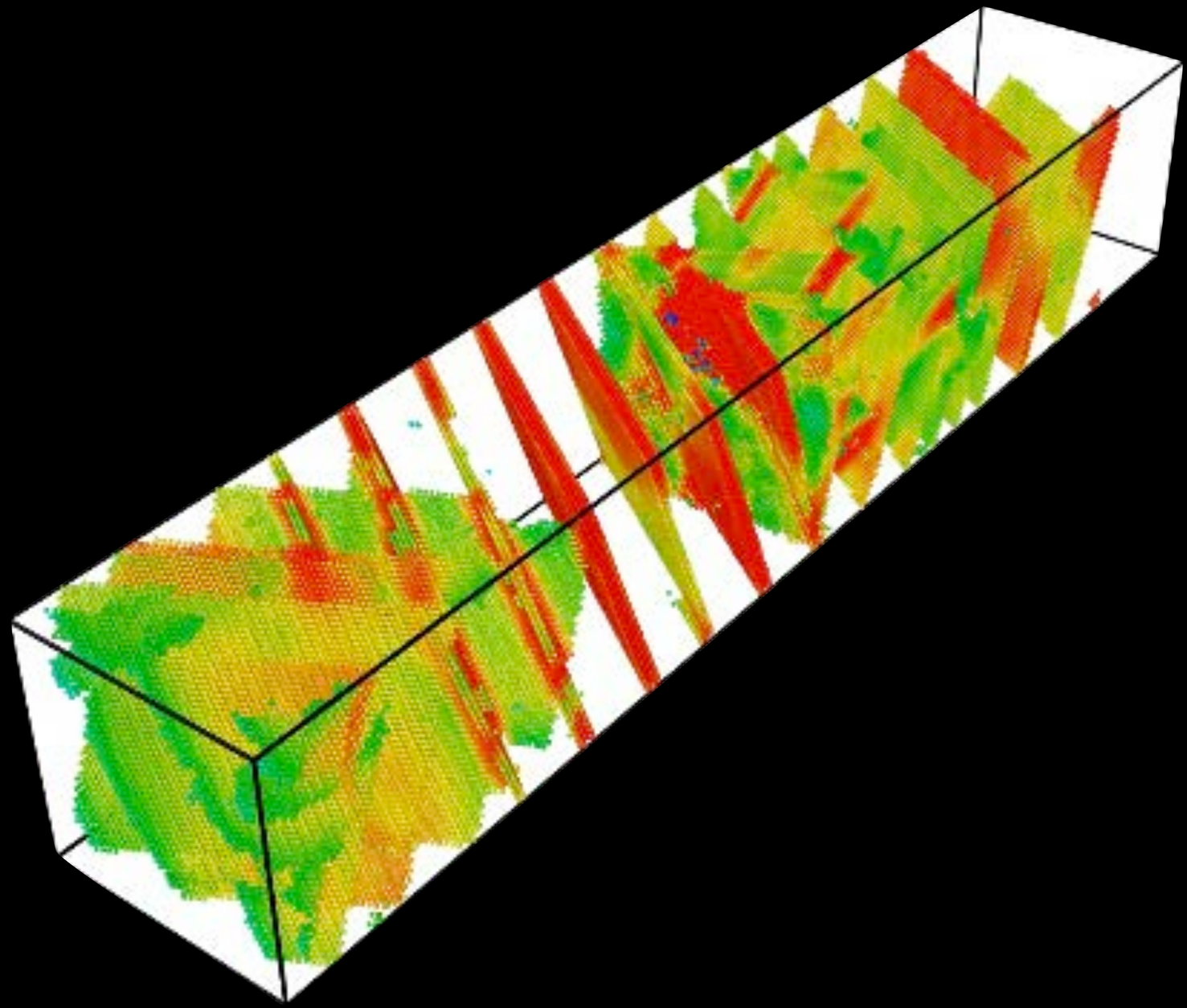
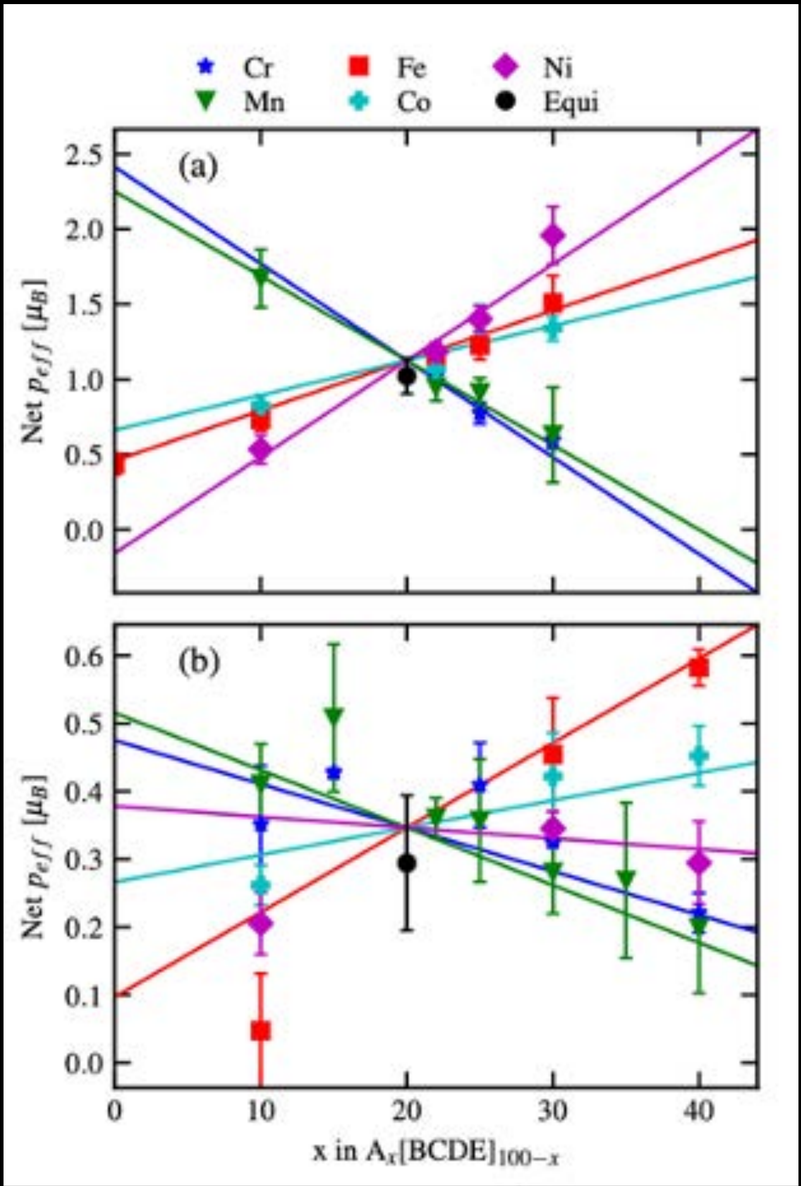




What About Magnetic Properties?



- Tuning the magnetic properties as a function of the composition…Towards multifunctional alloys by design
  - We tested twenty two compositions with varying compositions over a large temperature range.
  - We identified two transitions: a spin-glass like transition and a ferrimagnetic transition.
  - We showed that we can find compositions for which we can tune where these transition occur or when they can be suppresses.
  - Ab initio simulation helped us track the origin to the role of individual elements on effective magnetic moments and cross-elements interactions.

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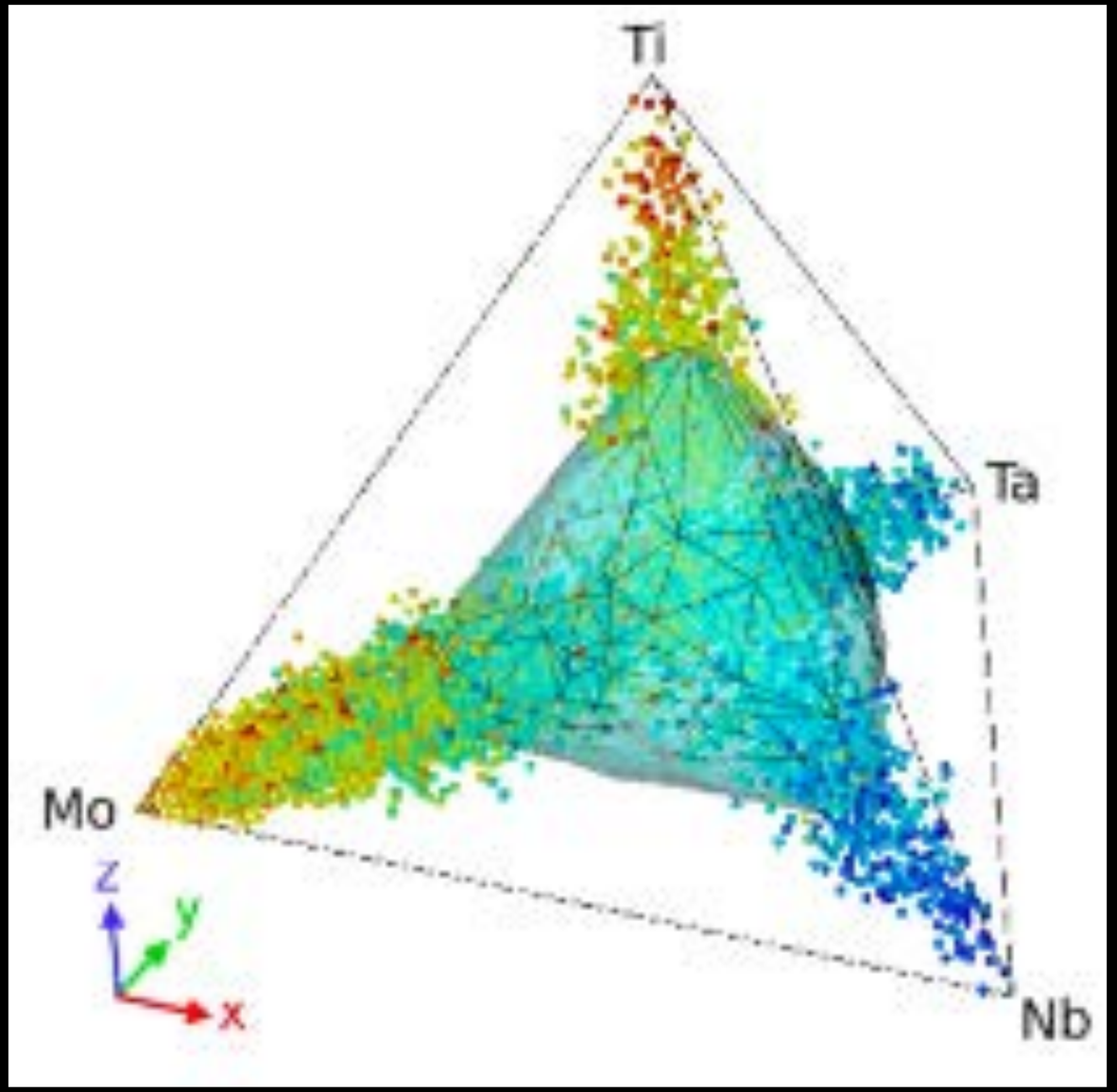
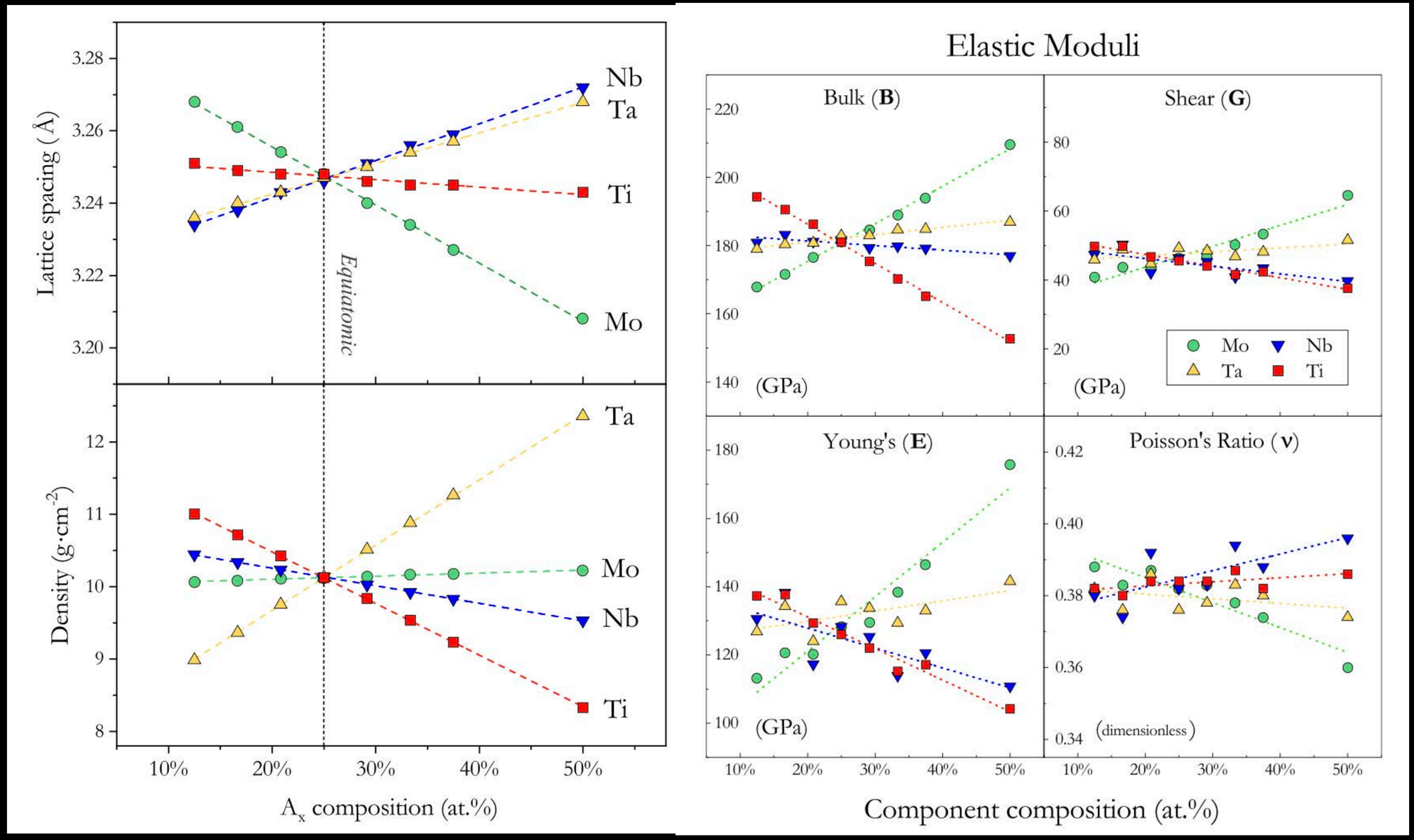
Is configurational entropy all we need?

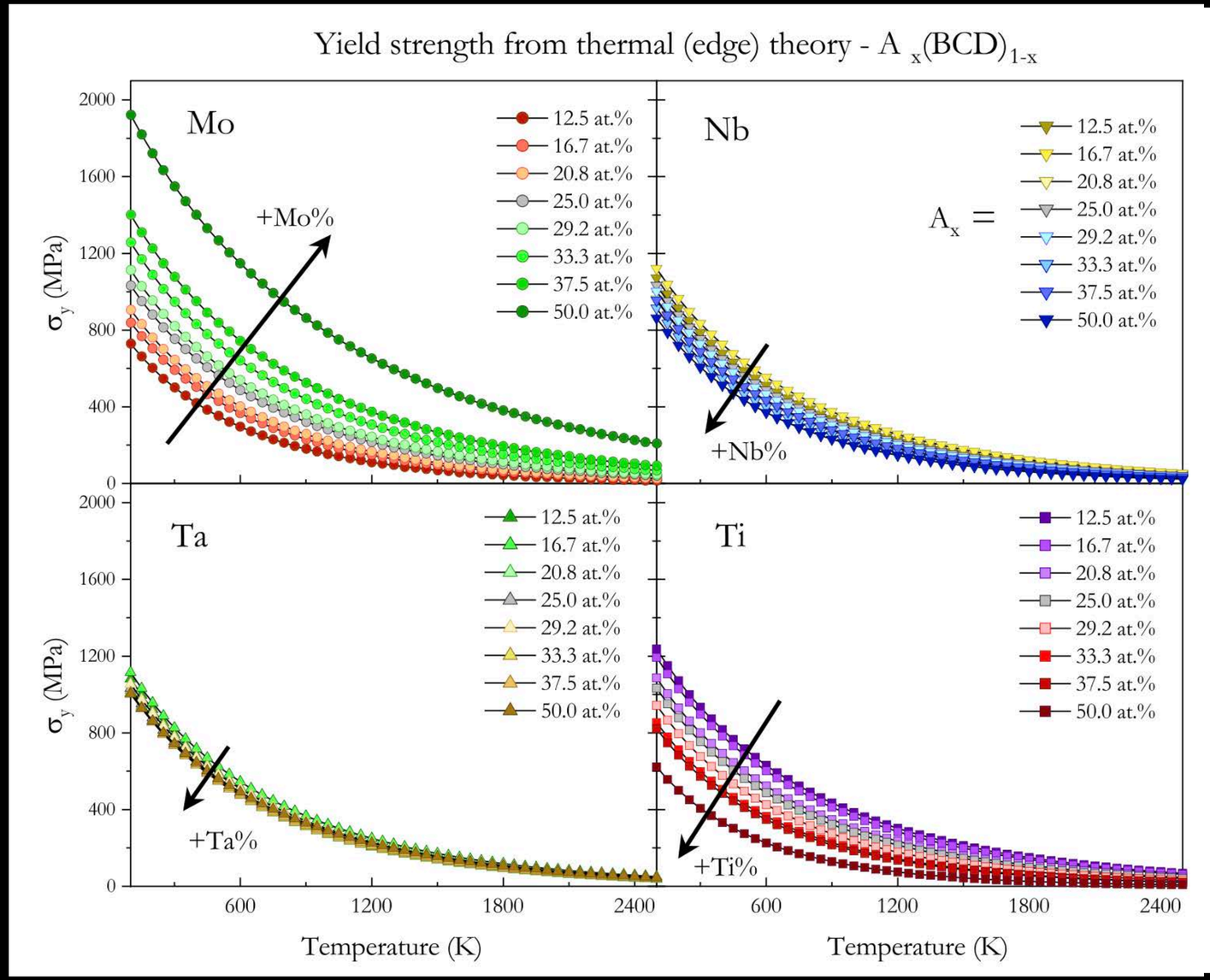
Refractory Complex Concentrated Alloys

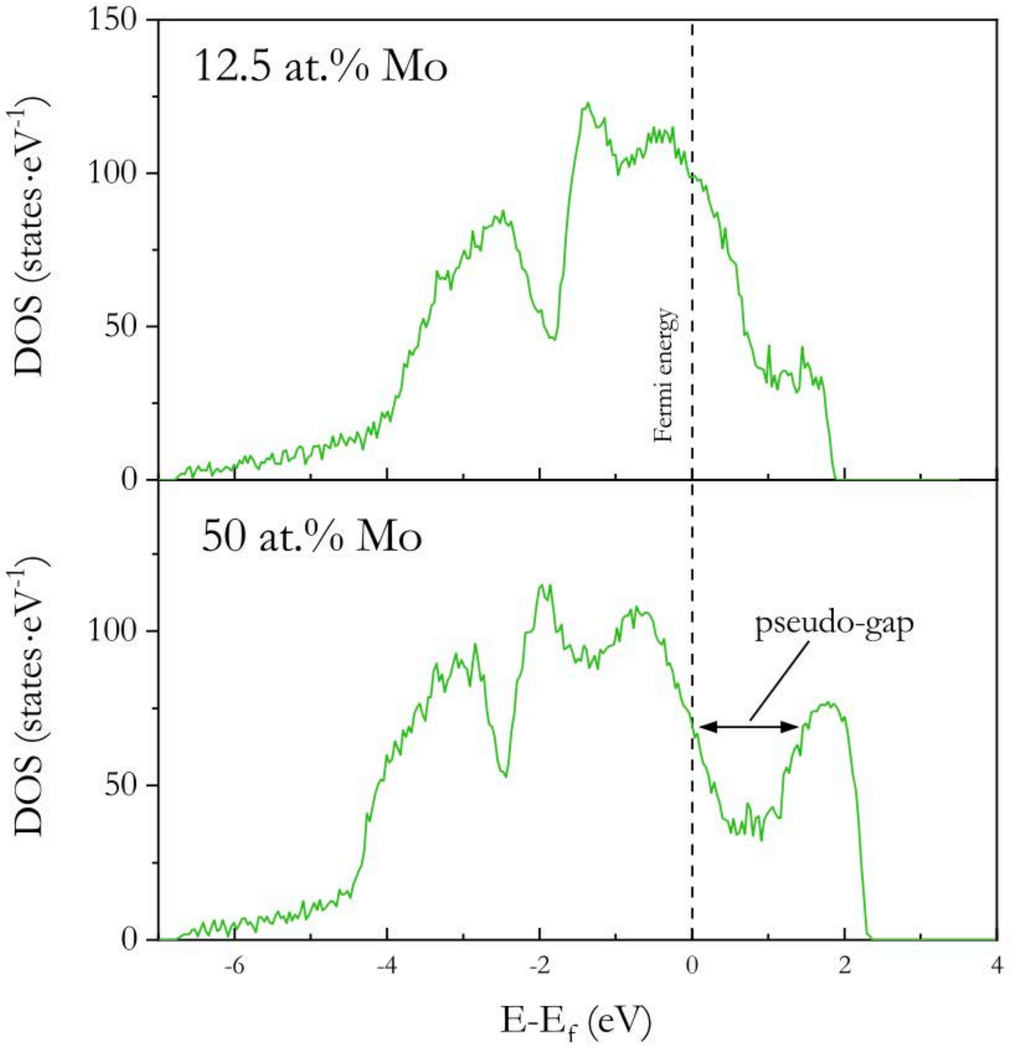


Compositional Effects on ThermoMechanical Properties



COMPOSITIONAL EFFECTS ON THERMOMECHANICAL PROPERTIES





Reality Check

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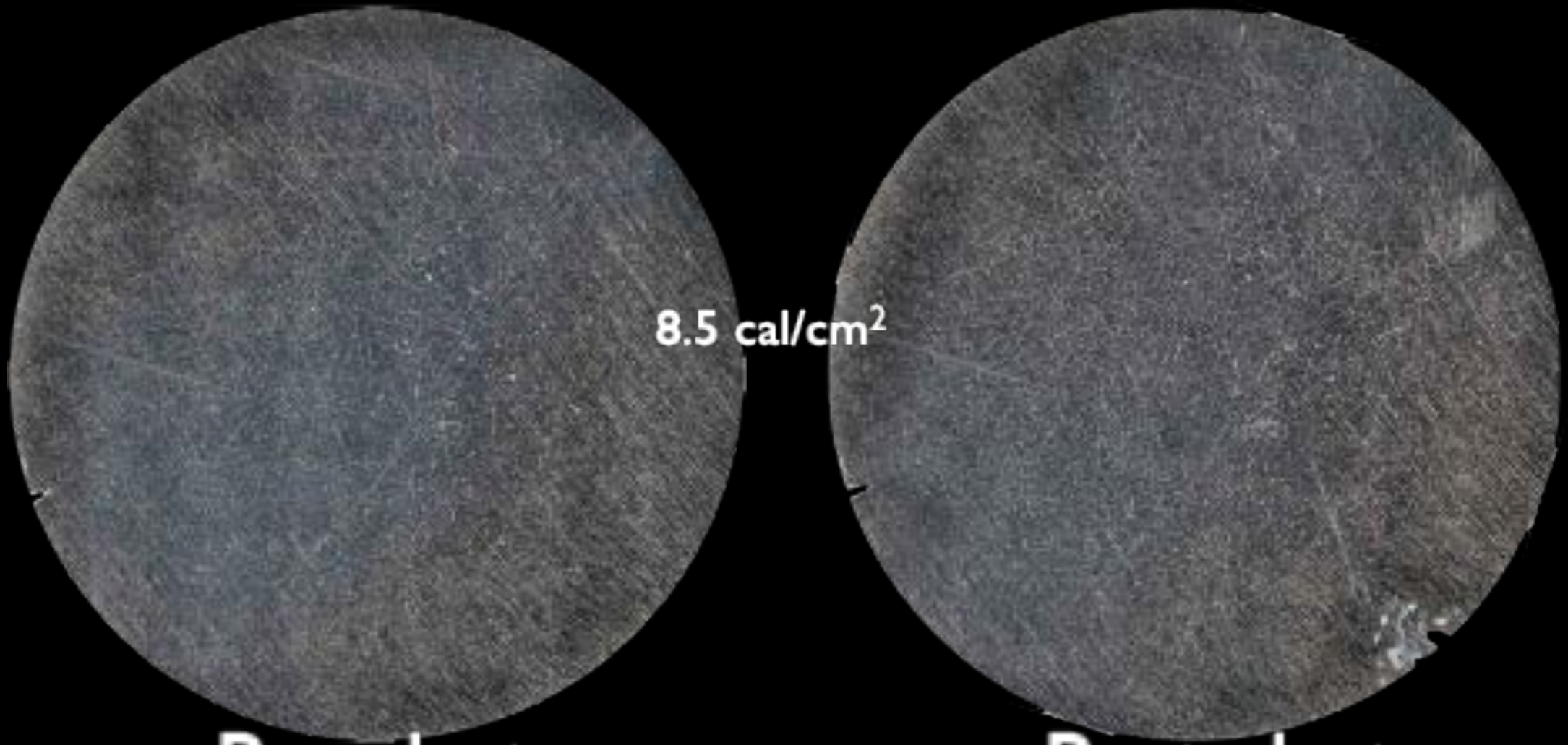
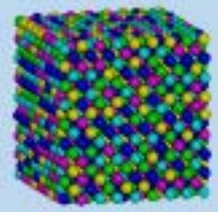


SUMMARY

HEAs



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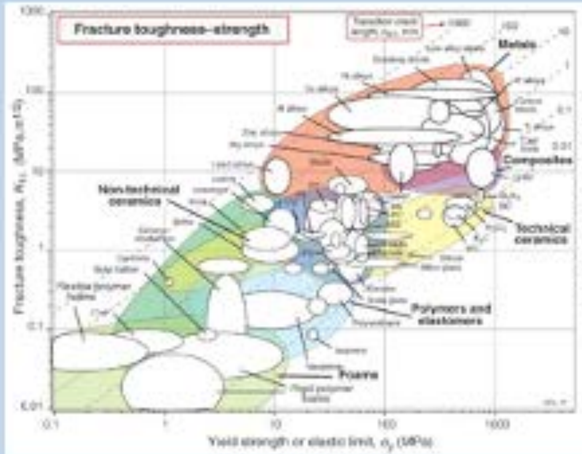

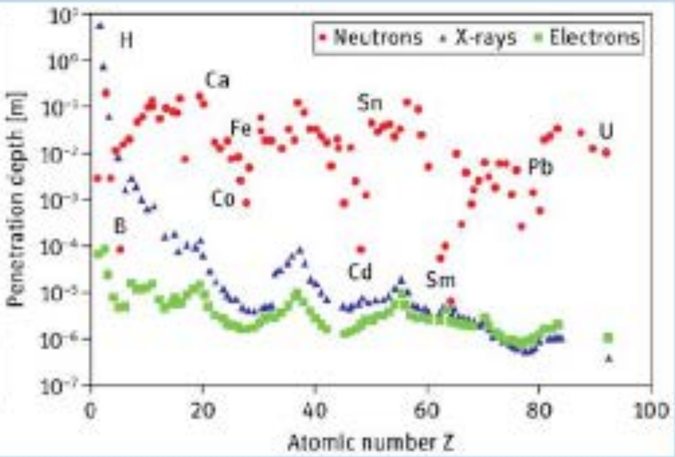

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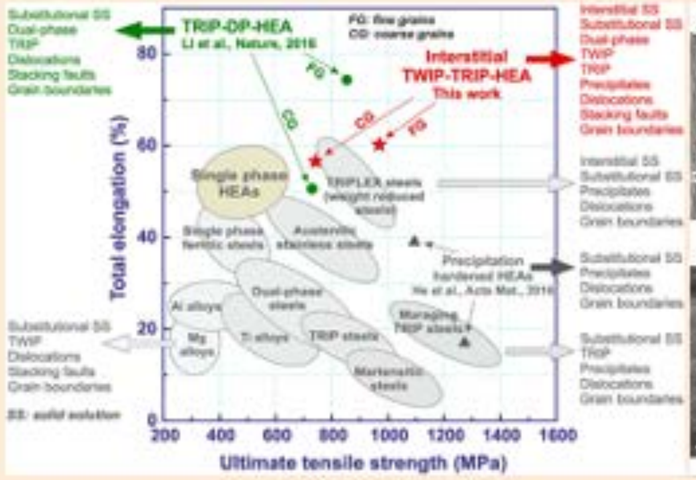

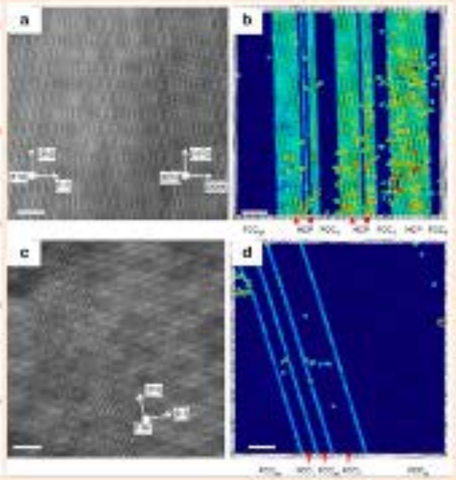

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