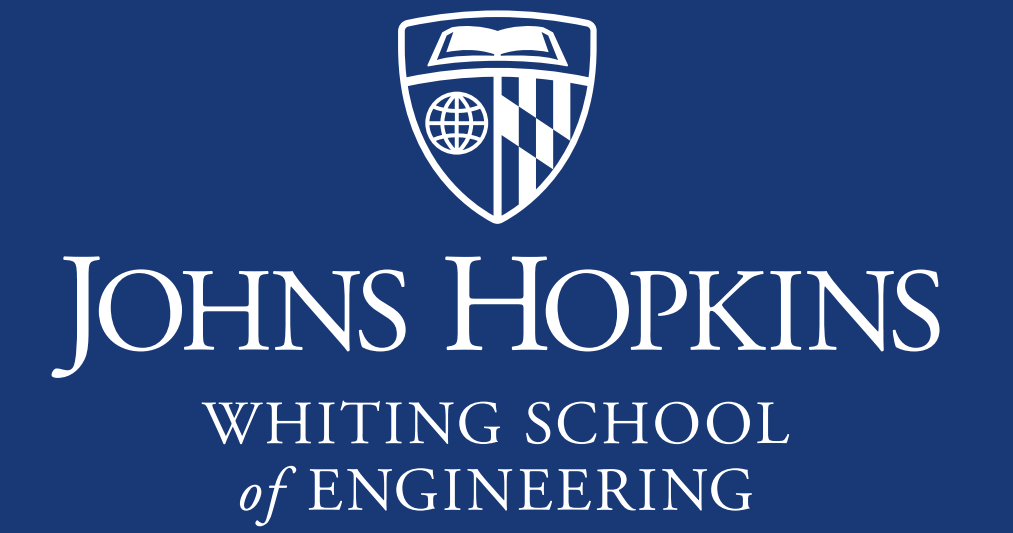


Utilizing Thermomechanical Processing to Design Optimized Biodegradable Mg-Ca Alloys



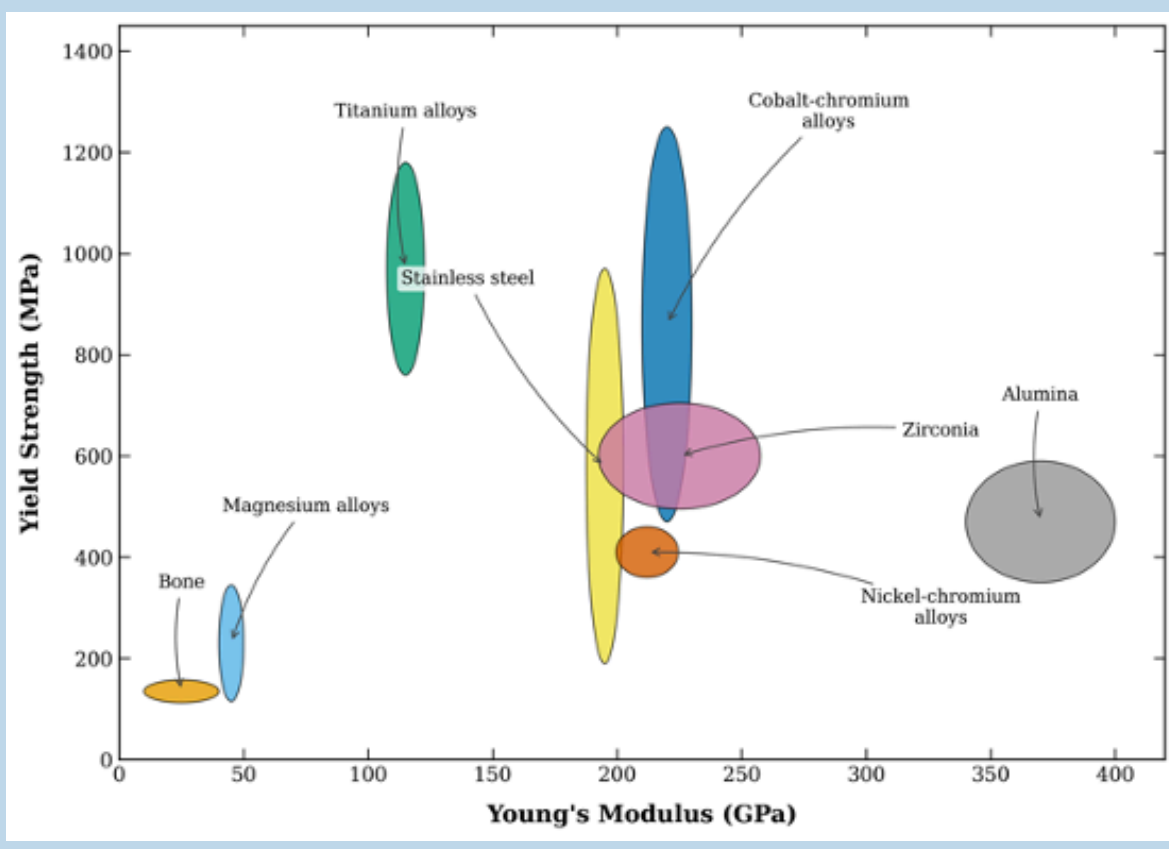
Andrew Kim¹, Sreenivas Raguraman^{1,2}, Adam J. Griebel³, Timothy P. Weihs^{1,2}
¹Department of Materials Science and Engineering, Johns Hopkins University
²Hopkins Extreme Materials Institute, Johns Hopkins University
³Fort Wayne Metals, Fort Wayne, Indiana



Engineering an Alternative

Current permanent implants exhibit stress shielding, increasing fracture and surgeries from bone degeneration

- Mg alloys are promising:
- Similar mechanical properties to bone
 - Biocompatible
 - Biodegradable



Biomedical Mg-Ca Alloys



Bioretec RemeOs (above) and U&I Co RESOMET (right) demonstrate practicality

Mg - 0.3 wt.% Ca Binary Alloy

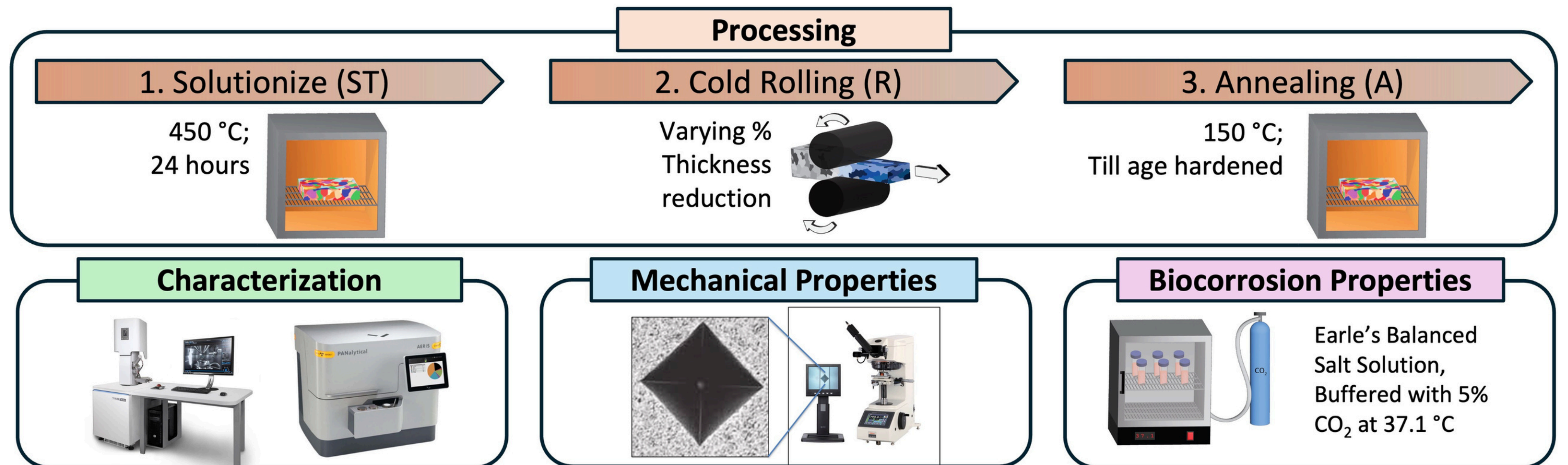
- Reduced cytotoxicity risks
- Lower concentration of secondary phases
- Controlled corrosion behavior

Challenge

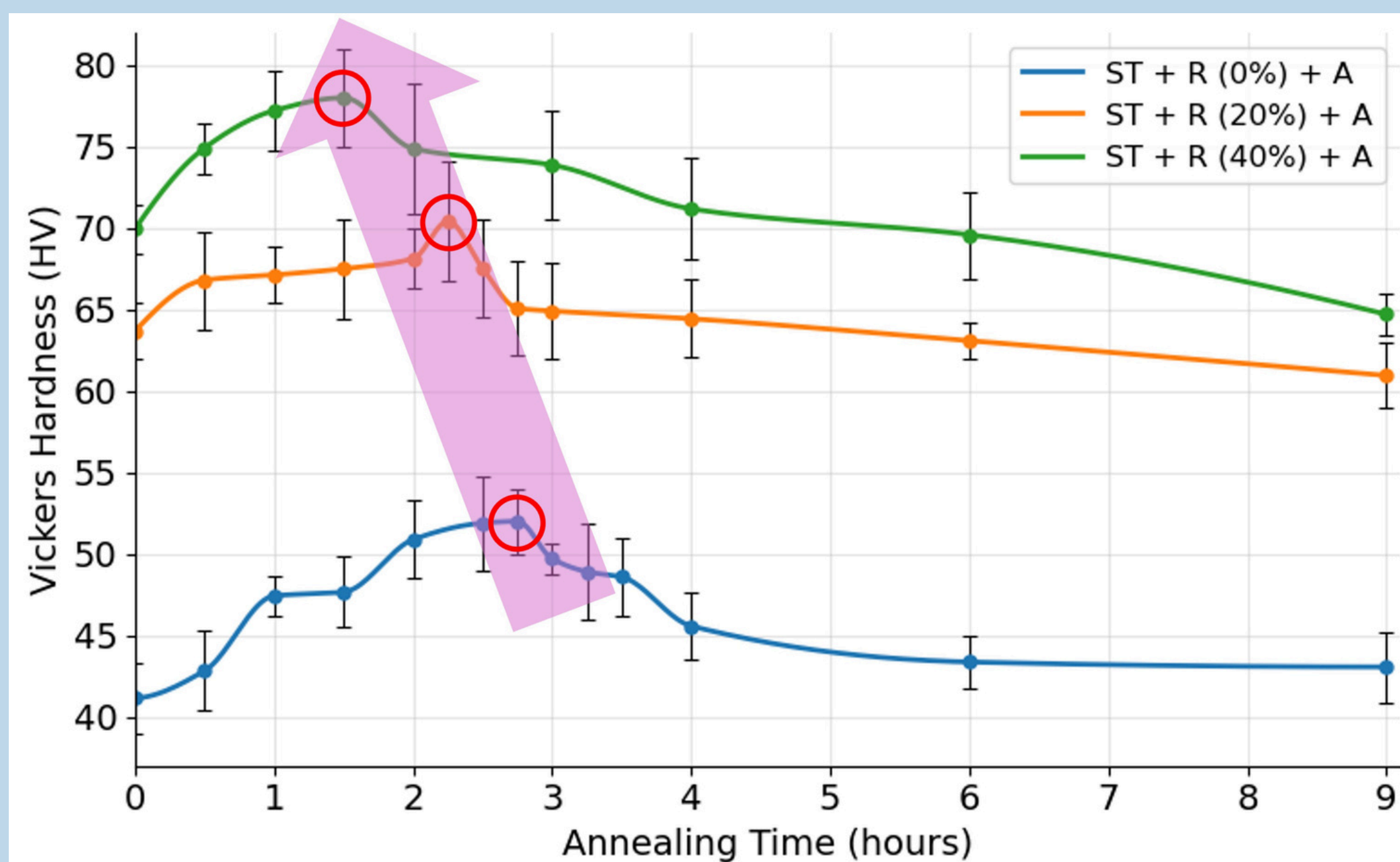
Rapid corrosion prematurely degrades mechanical properties and causes hydrogen evolution.

Goal

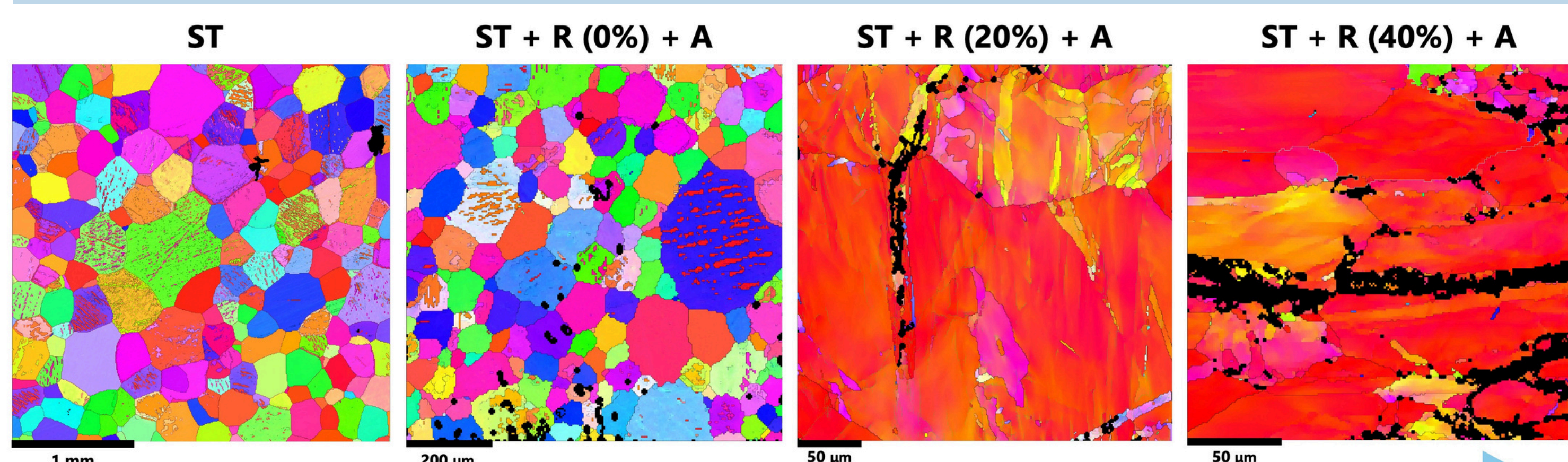
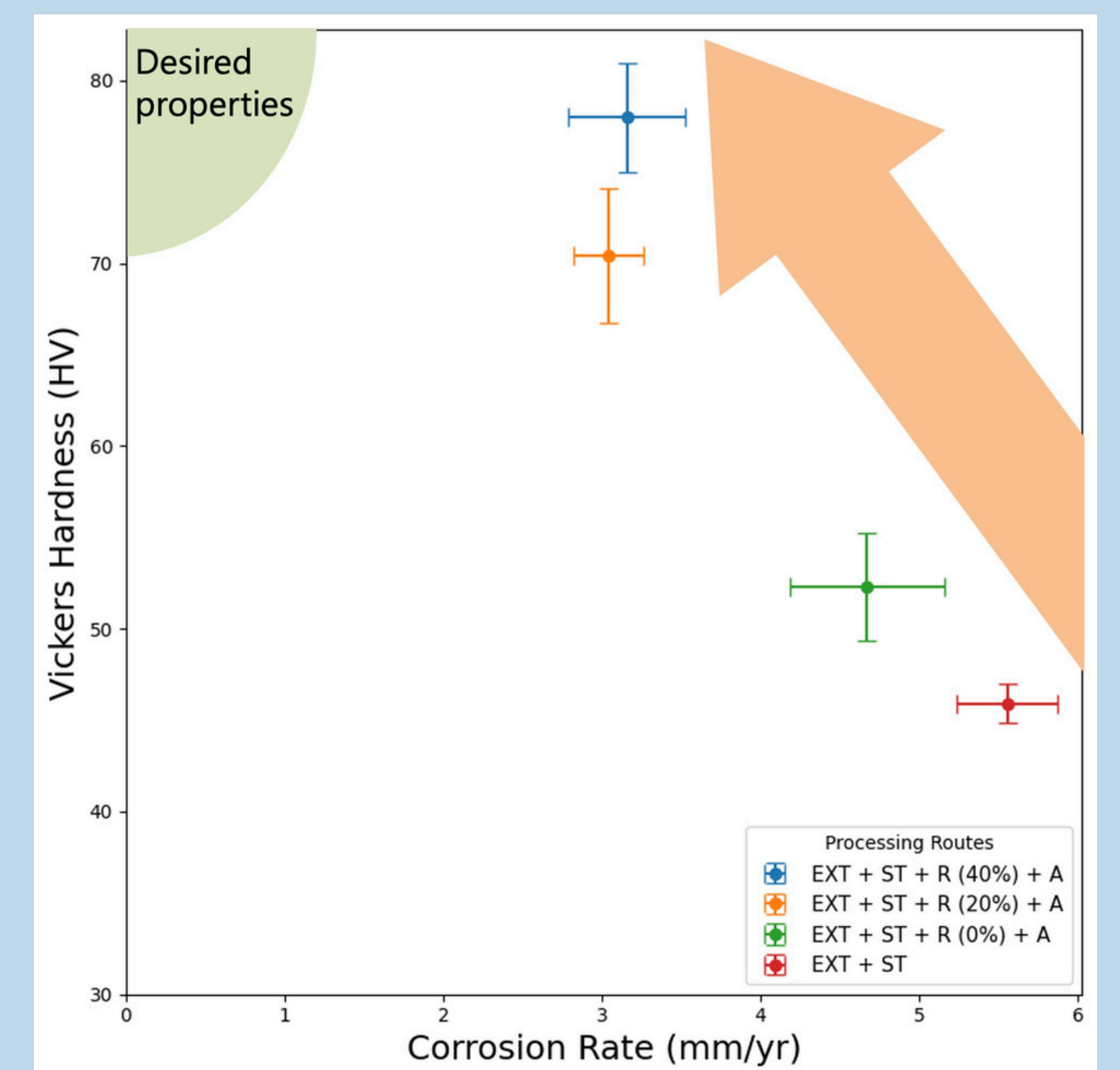
Identify thermomechanical processing routes and understand their microstructures to optimize mechanical and corrosion resistance properties.



Mechanical and Corrosion Properties



- ST + R(40%) + A achieves optimized properties
- Rolling increase maximum HV and reduces time to achieve this condition



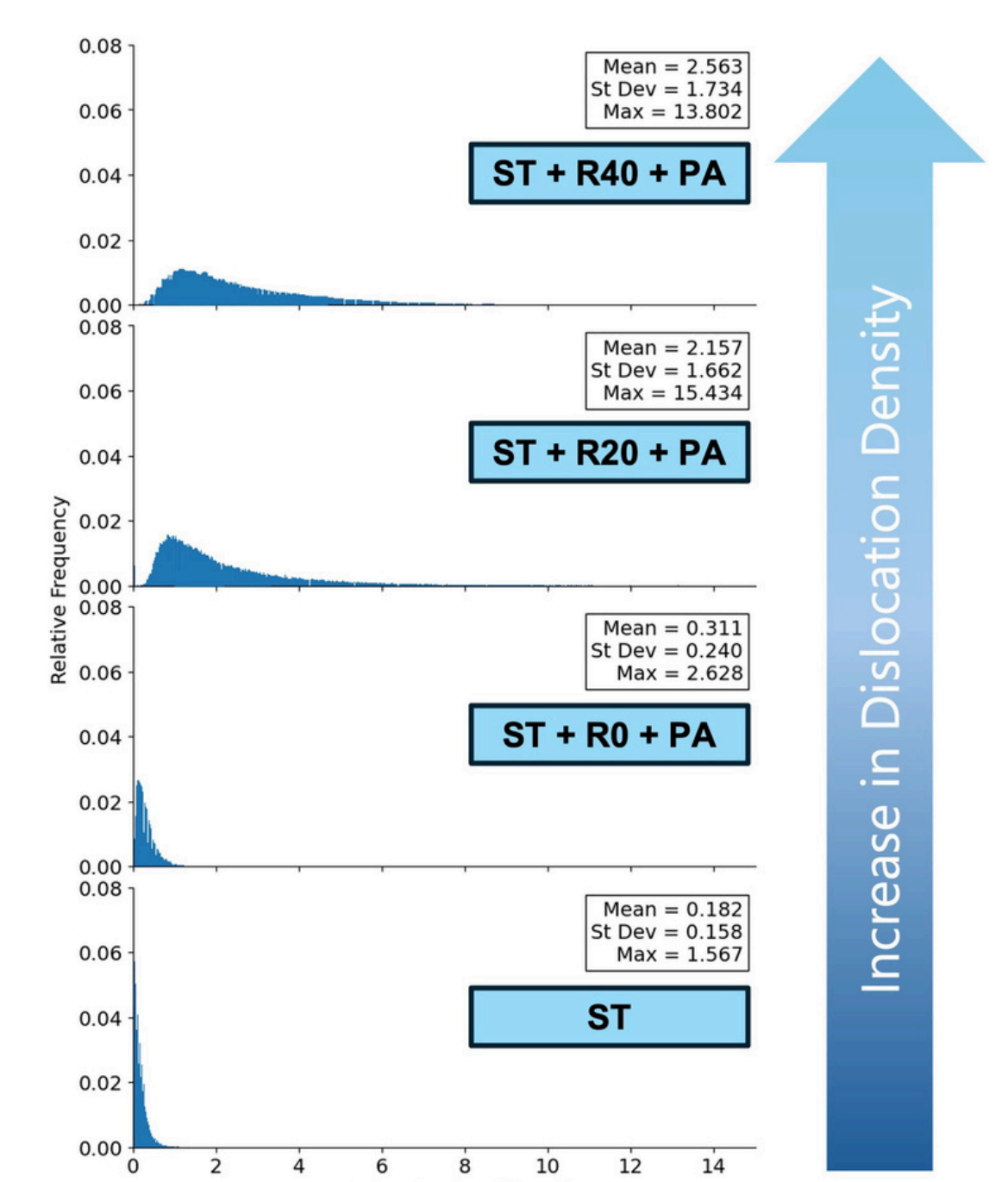
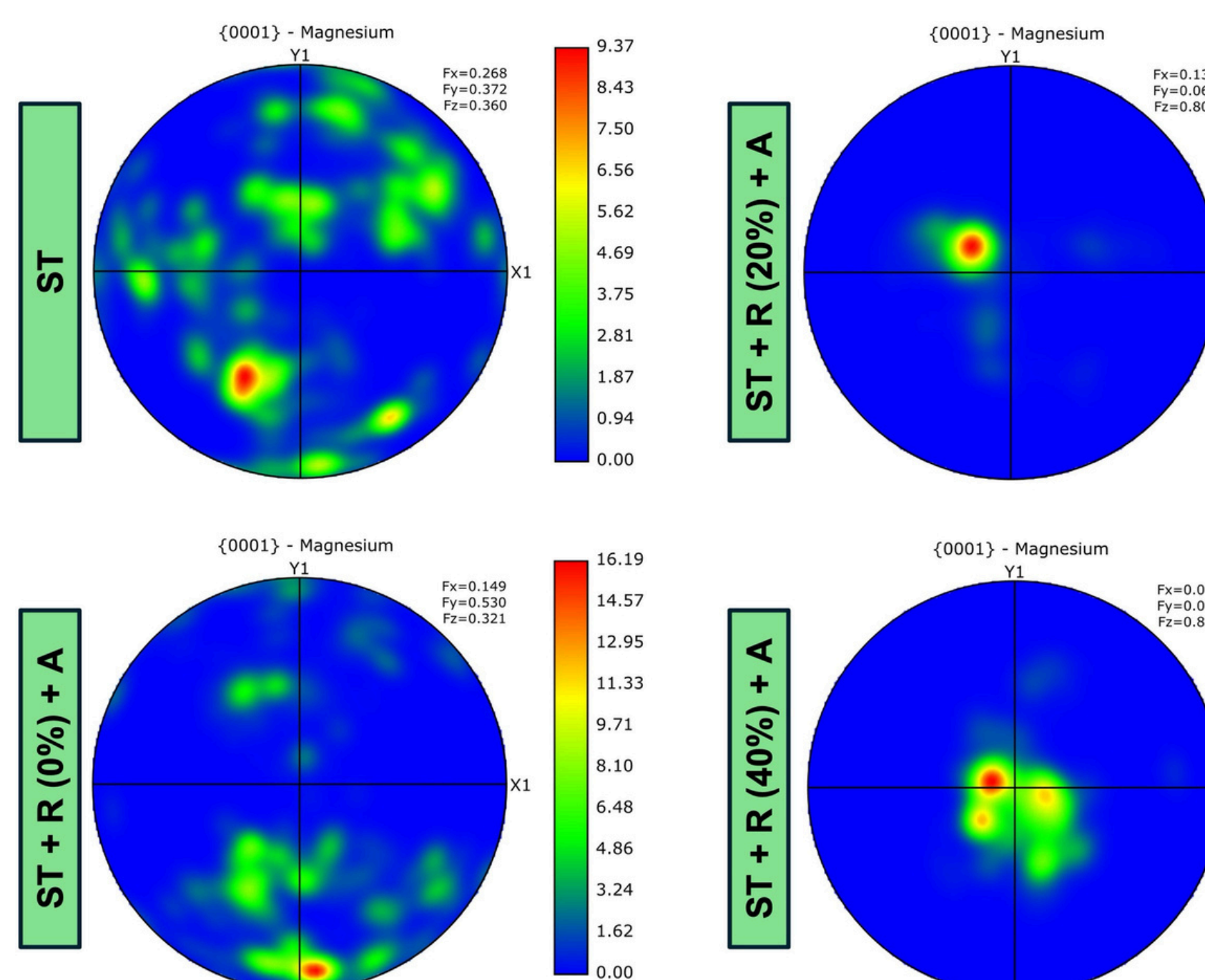
Grain Size Reduction

Grain Evolution

- Twinning observed in non-rolled conditions
- Recrystallization upon annealing
- Equiaxed to smaller elongated grains
- Both 20% and 40% are similar grain sizes

Texture and GND

- Localized intensity in basal orientation for rolled samples
- Grains experience more texture angles in 40% rolled
- Dislocation density as critical strengthening mechanism



Increase in Dislocation Density

Conclusion and Next Steps

- ST + R (40%) + A achieved optimized property balance
- Defect induced precipitation and twinning annihilation may control corrosion, grain size and dislocation density for hardness
- Propose EDS for pre- and post-corrosion precipitate analysis
- Longer duration corrosion and corrosion-fatigue

Acknowledgement

I would like to thank Sreenivas Raguraman, Adam Griebel, and Professor Tim Weihs for their support and mentorship. Thank you to Tunde Ayodji for assistance with visuals and to HEMI and WSE Manufacturing with sample preparation and characterization.