

Introduction/Background

- Nitinol-60 is a Ni-Ti shape memory alloy (60% Ni, 40% Ti by mass).
- Applications: dental, aerospace, and hydrogen energy systems.
- Hydrogen interaction affects mechanical stability in high-temperature environments.
- This study evaluates hydrogen uptake as a function of heat treatment temperature (300–900°C).

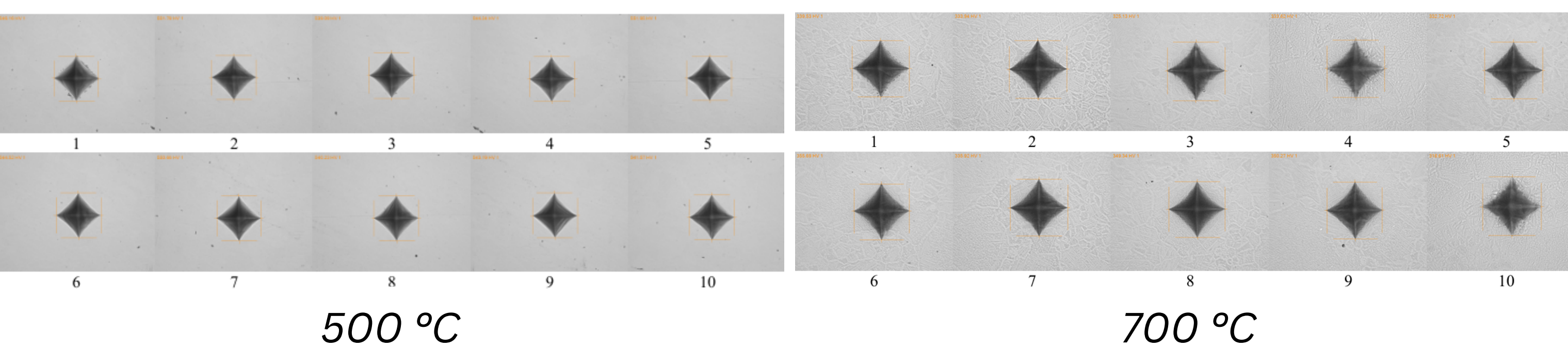
Methodology

- Four NiTi-60 samples (4.8–5.0 g) exposed to continuous hydrogen flow.
- Heat treatments: 300°C, 500°C, 700°C, 900°C
 - Ramp rate: 10°C/min
 - Hold time: 1 hour
- Cooled in hydrogen atmosphere.
- Hydrogen uptake determined via pre-/post-treatment mass comparison.

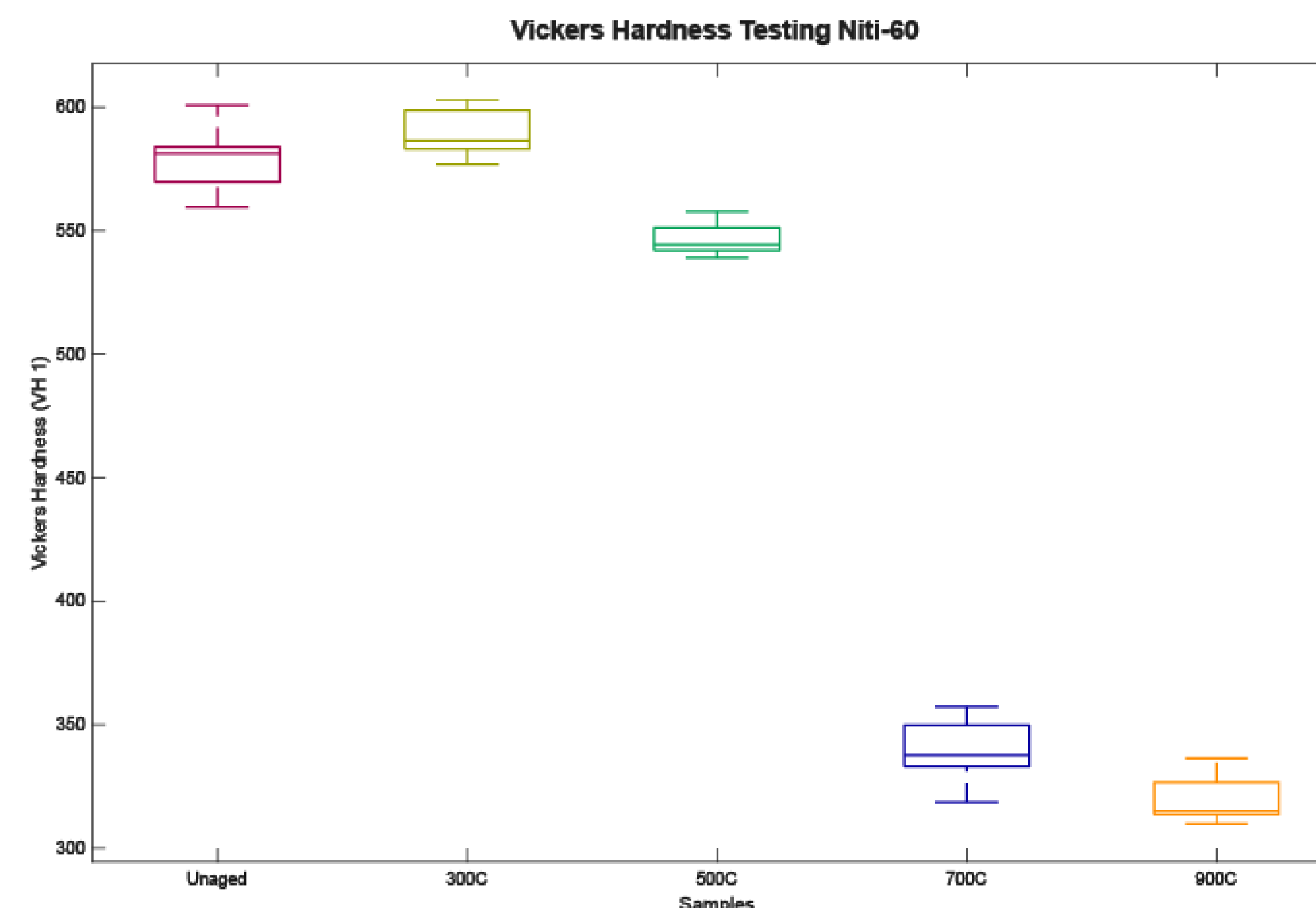
Results

- Hardness remains stable through 300°C.
- Significant mechanical degradation begins at 500–700°C.
- Reduced modulus trends confirm loss of structural integrity with increasing hydrogen uptake.
- ≥700°C treatment results in drastic hardness reduction.

Vickers Hardness Testing imaging at select points

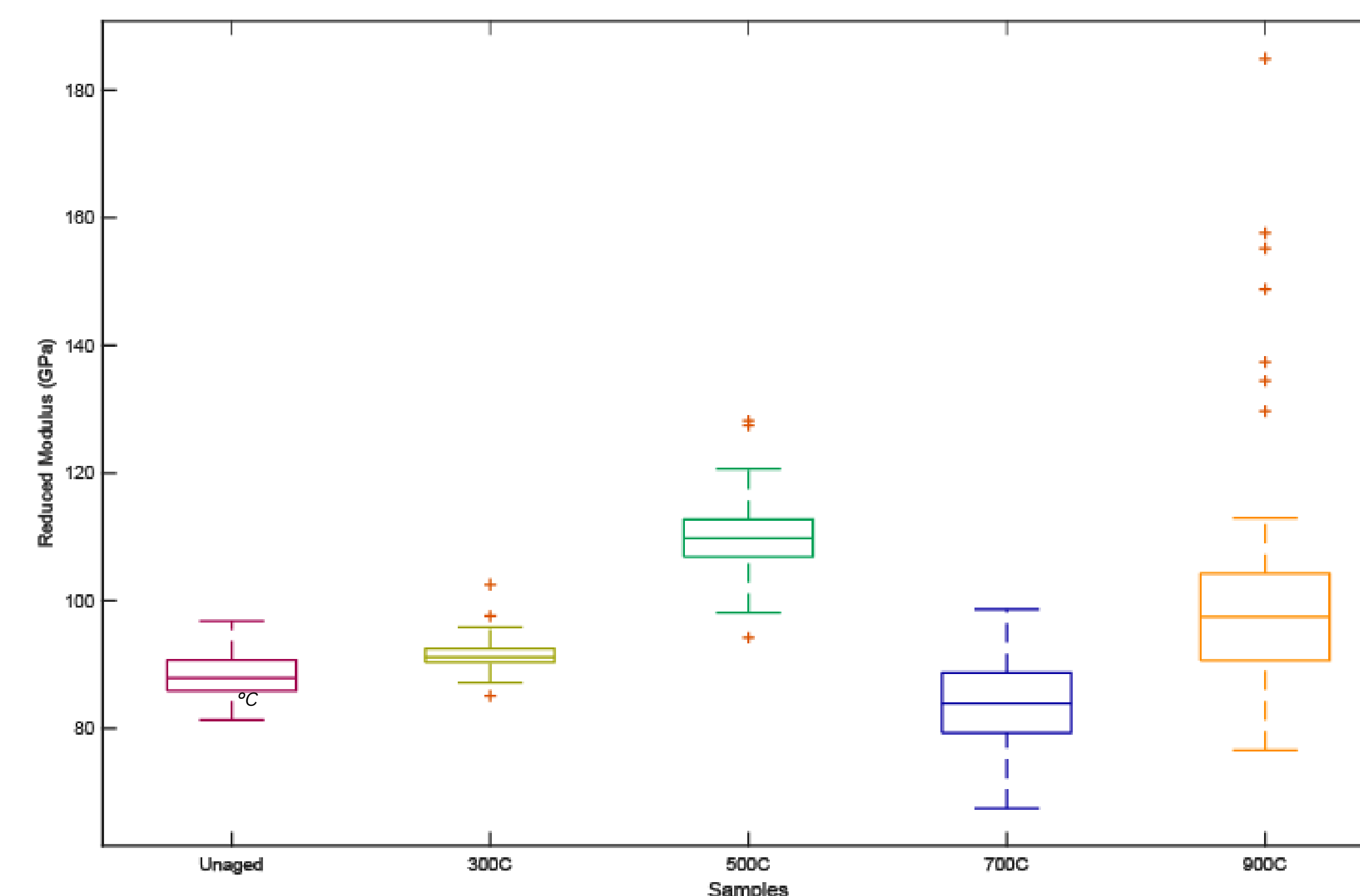


Vickers: Hardness Testing

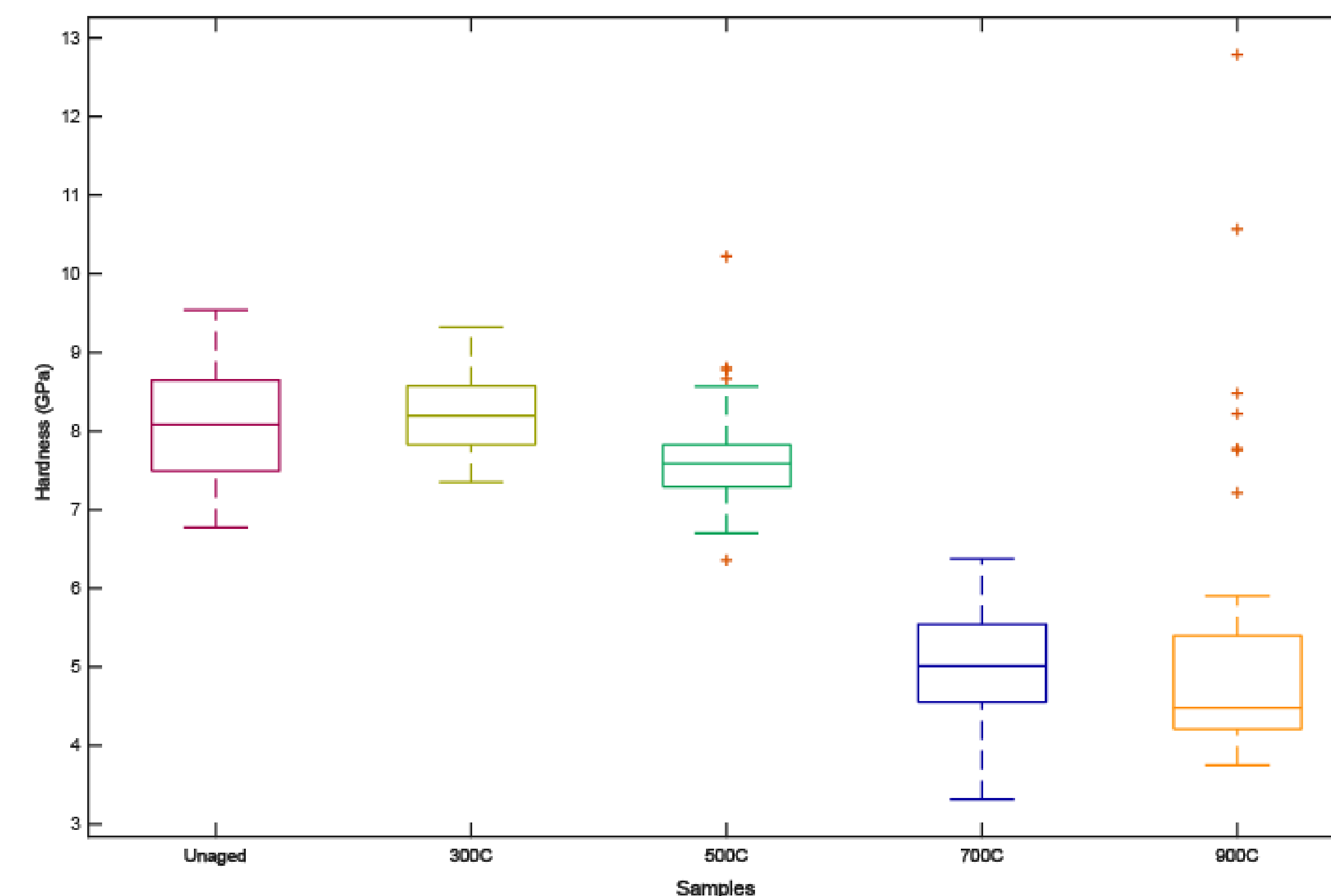


Nanoindentation: Hardness & Reduced Modulus

Nanoindentation Reduced Modulus Test Niti-60



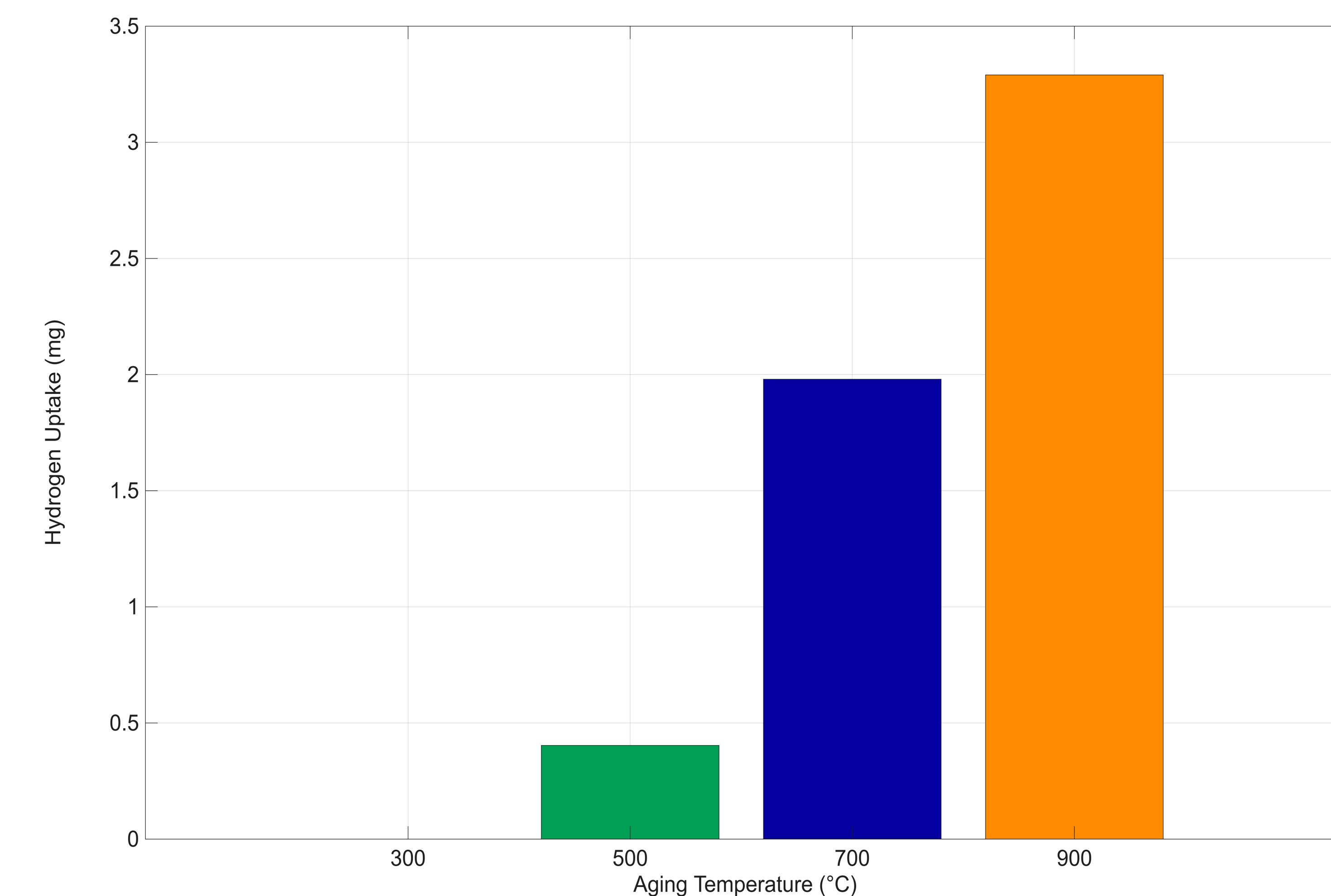
Nanoindentation Hardness Test Niti-60



Significance

- Hydrogen uptake above 500°C drives phase transformation and mechanical degradation in NiTi-60.
- Understanding this relationship enables improved prediction of material behavior and safer operating limits for NiTi-60 in hydrogen environments.
- Next Step: Conduct XRD analysis to confirm phase transformation within the 500–700°C range.
- Future Work: Refine experimental conditions by eliminating oxygen and other non-inert gases prior to aging to ensure lattice purity.

Hydrogen Uptake (mg) Vs. Aging Temp (°C)



References

Louthan, M. R., Donovan, J. A., & Caskey, G. R. (1975). Hydrogen diffusion and trapping in nickel. *Acta Metallurgica*, 23(6), 745–749. [https://doi.org/10.1016/0001-6160\(75\)90057-7](https://doi.org/10.1016/0001-6160(75)90057-7)

Hydrogen embrittlement of Ni-Ti superelastic alloy aged at room temperature after hydrogen charging. (2007). *Materials Science and Engineering A*. <https://doi.org/10.1016/j.msea.2007.02.102>

Hydrogen-related degradation of mechanical properties of titanium and titanium alloys. (2009). *Journal of ASTM International*. <https://doi.org/10.1520/JAI101853>

Runciman, A. L. (2007). Effect of hydrogen on the phases, phase transitions, and hydride formation in nickel-titanium shape memory alloys (Order No. 29704340). California Polytechnic State University.

Aksu Canbay, C., Karaduman, O., & Özkuş, İ. (2020). Lagging temperature problem in DTA/DSC measurement during investigation of NiTi. *Journal of Materials Science: Materials in Electronics*.

Mechanical stability in NiTi-60 decreases sharply beyond 500°C due to hydrogen-induced phase transformation.