

# Effects of Room Temperature Aging on Hydrogen-Charged Nitinol

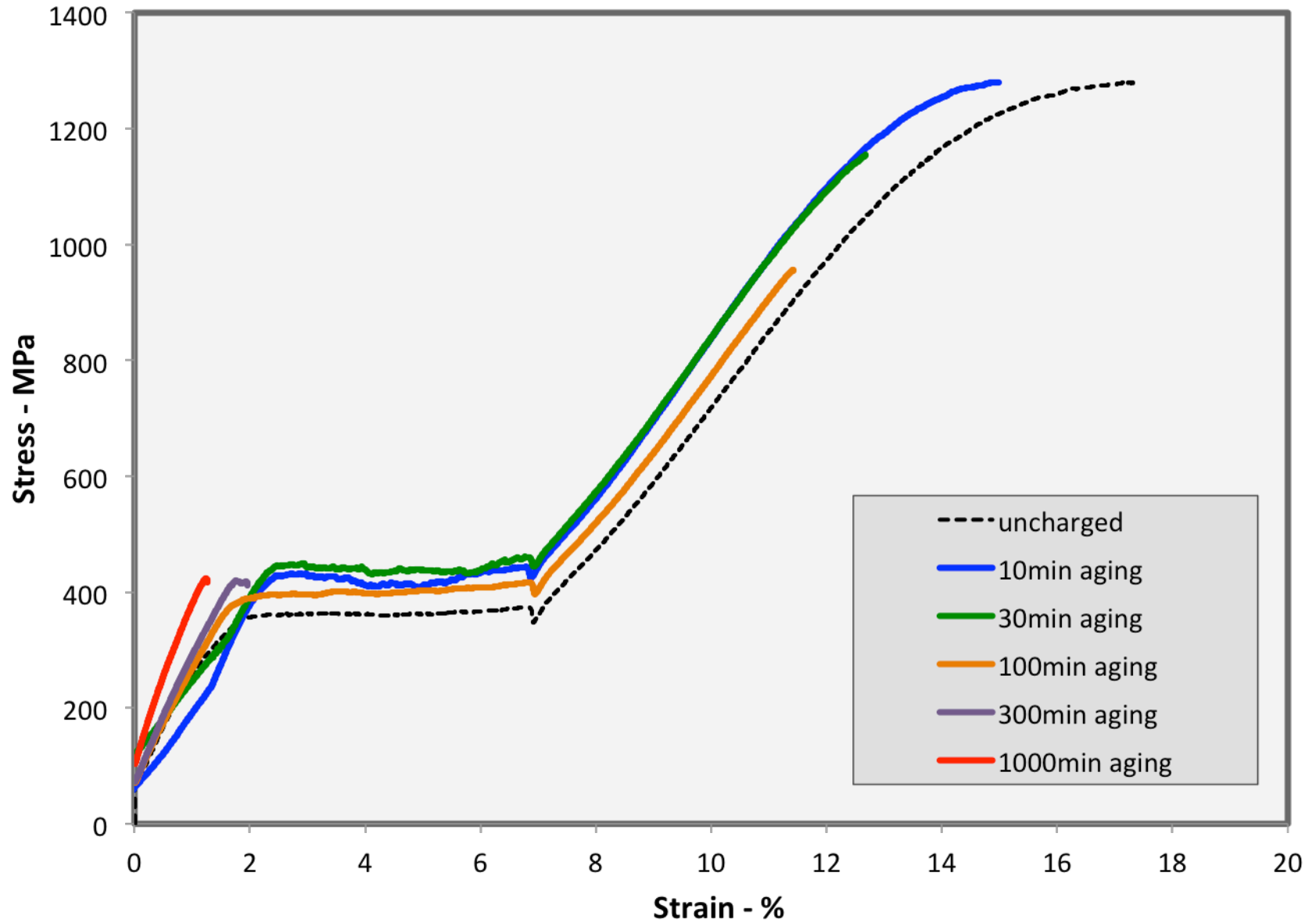
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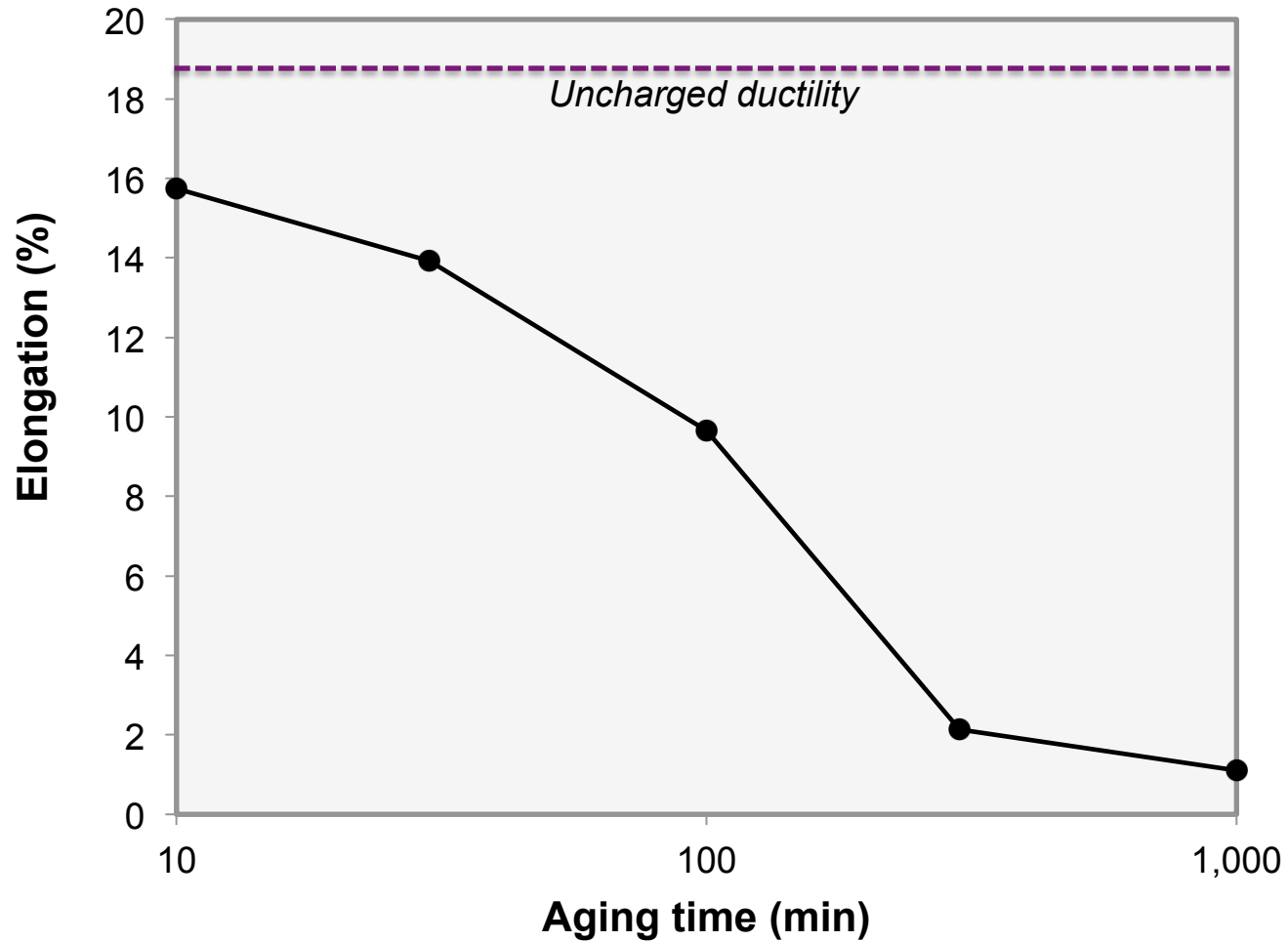
## Experimental:

- Charging:
  - 95% methanol - 5% sulfuric acid
  - T = -10°C
  - 30 volts
  - Reversed polarity after 60 sec EP to charging
  - Variable time (30-90 seconds) to control hydrogen uptake
- Hydrogen measured by extraction using a Leco DH603 analyzer
- All tensile tests done in triplicate on “dogbones” made from  $\phi$ 1.0mm wire

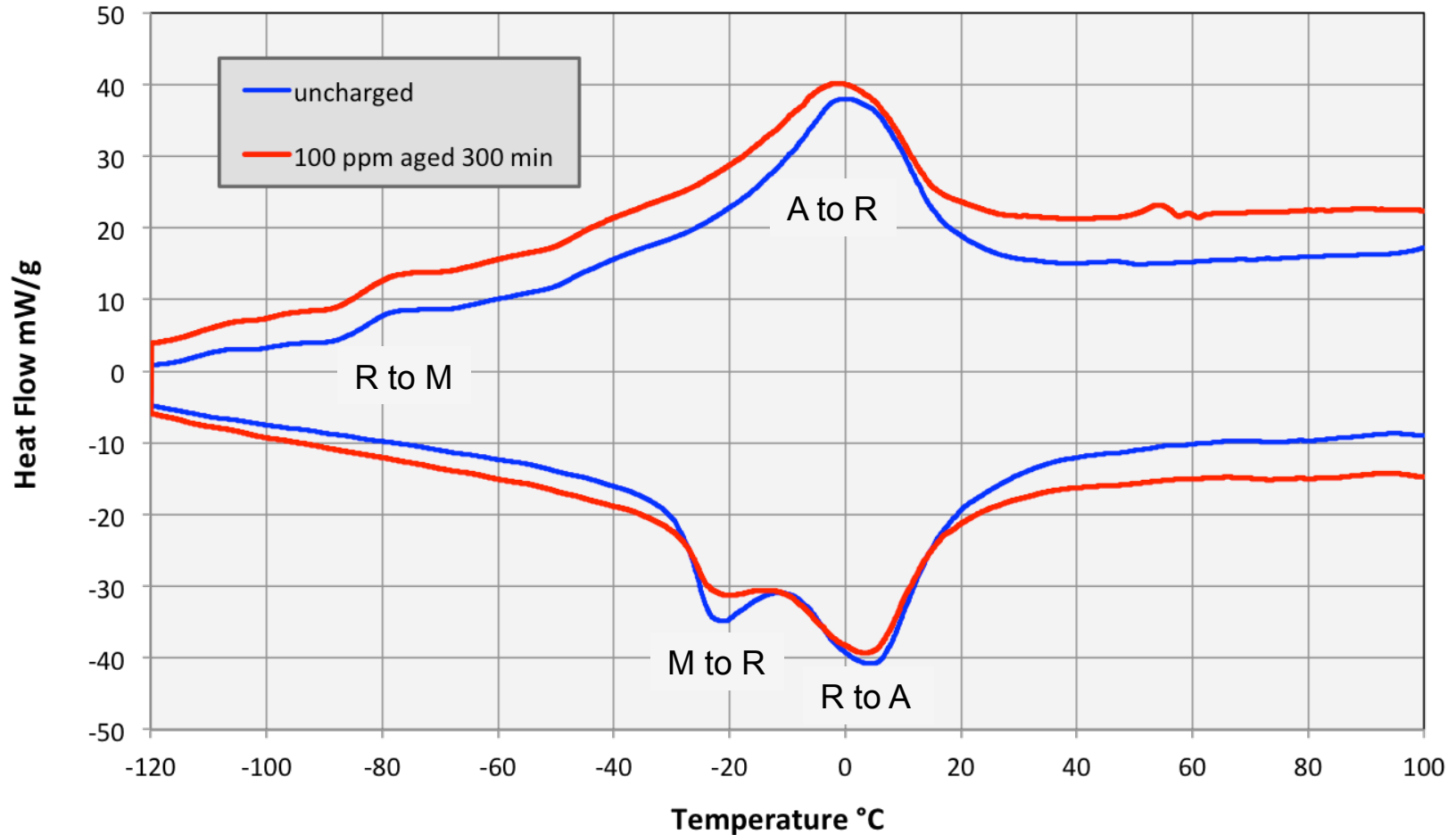
# Embrittlement effects:



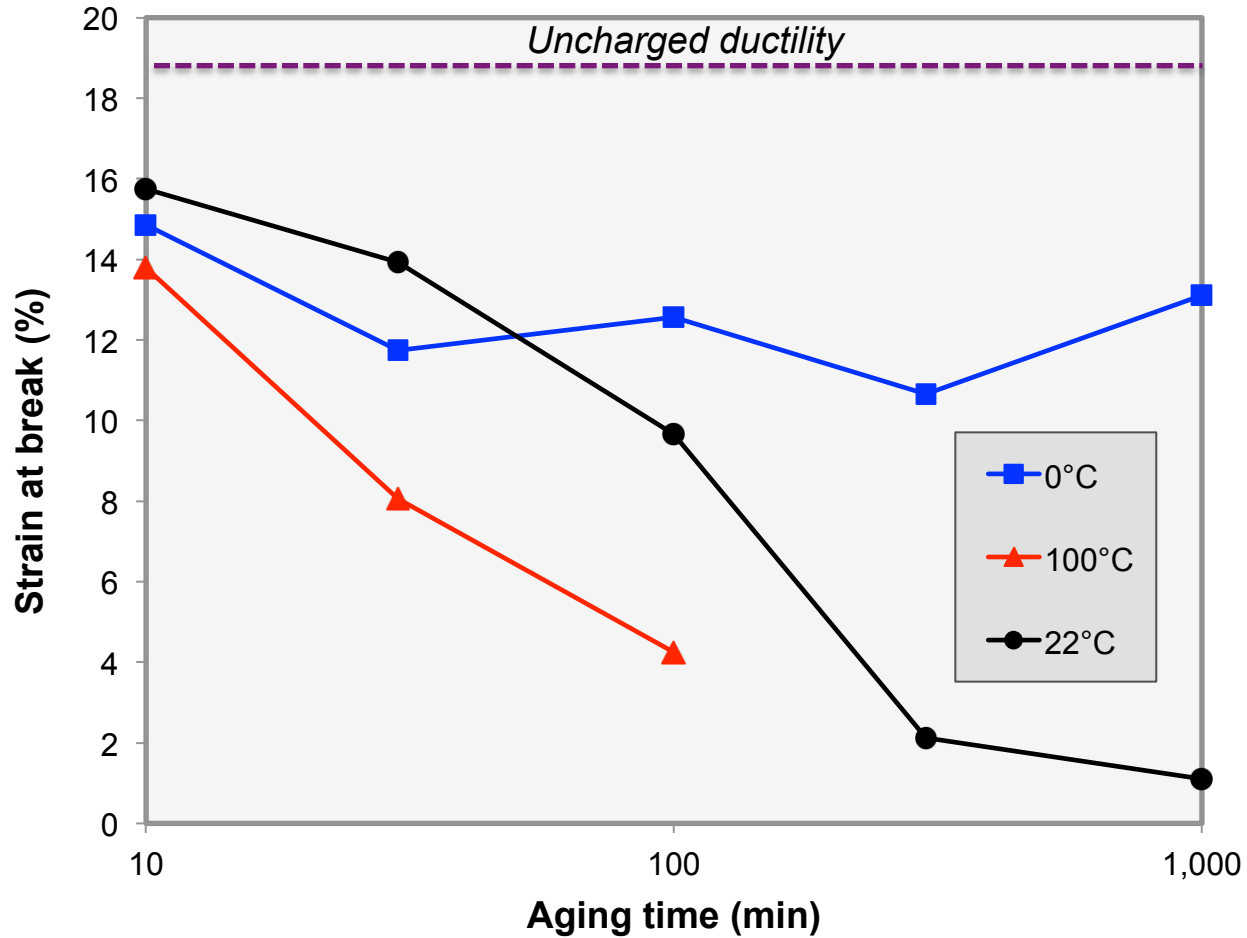
## Aging at room temperature: 150 wt. ppm H



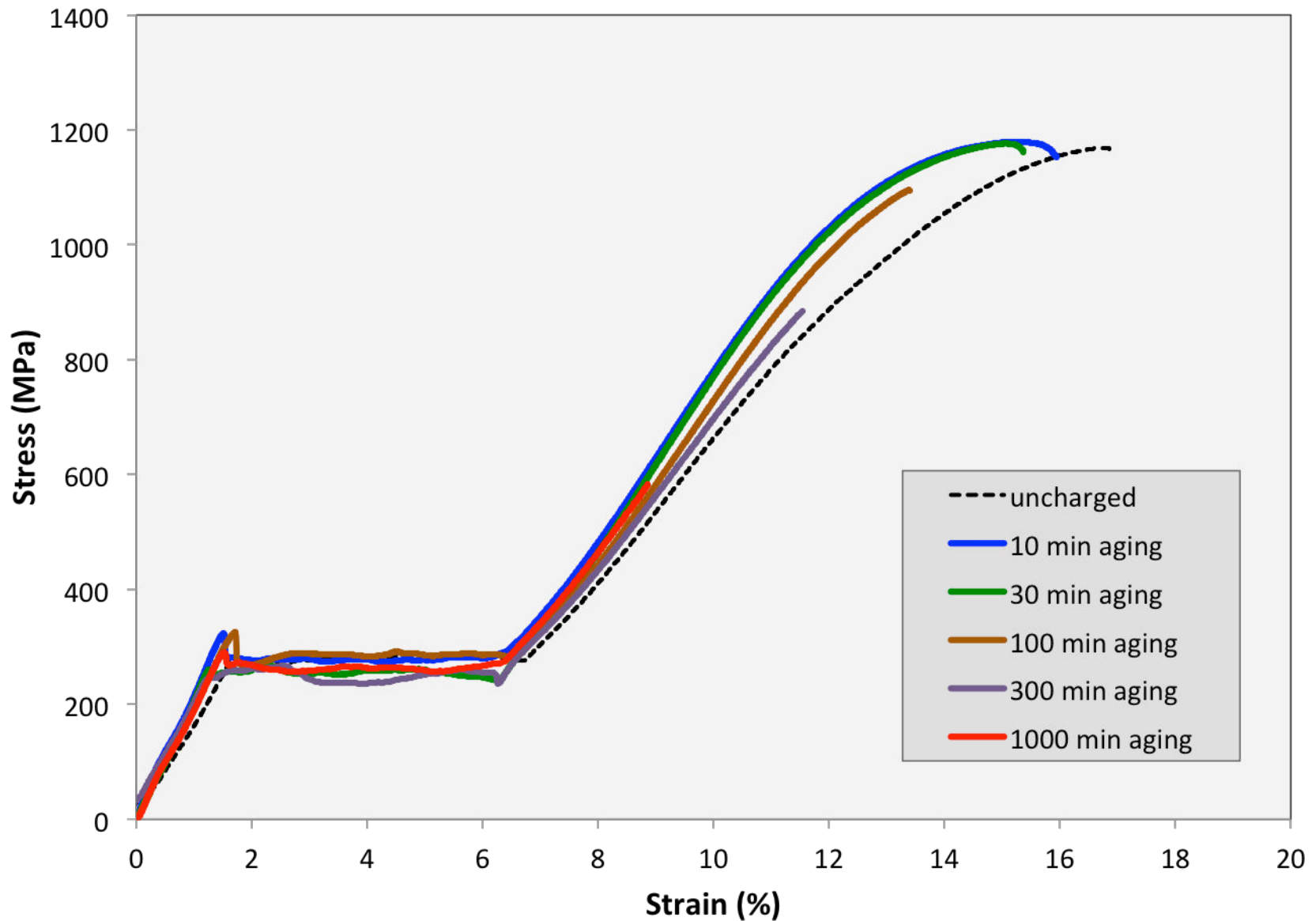
# DSC: No significant changes to any of the transformation temperatures during ageing



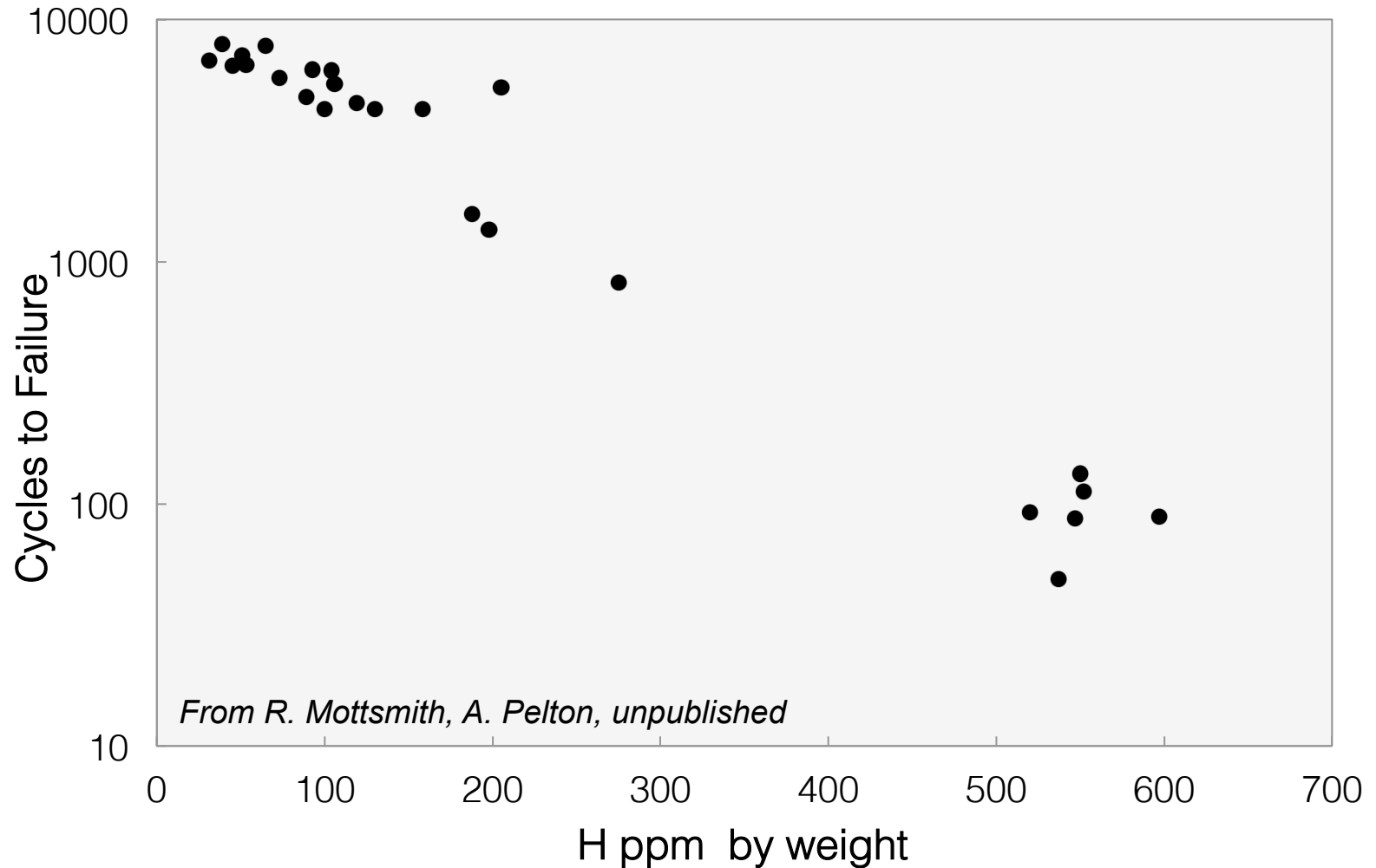
# Effect of aging temperature: 150 wt. ppm H



## Charged to 20-50 ppm and aged at RT

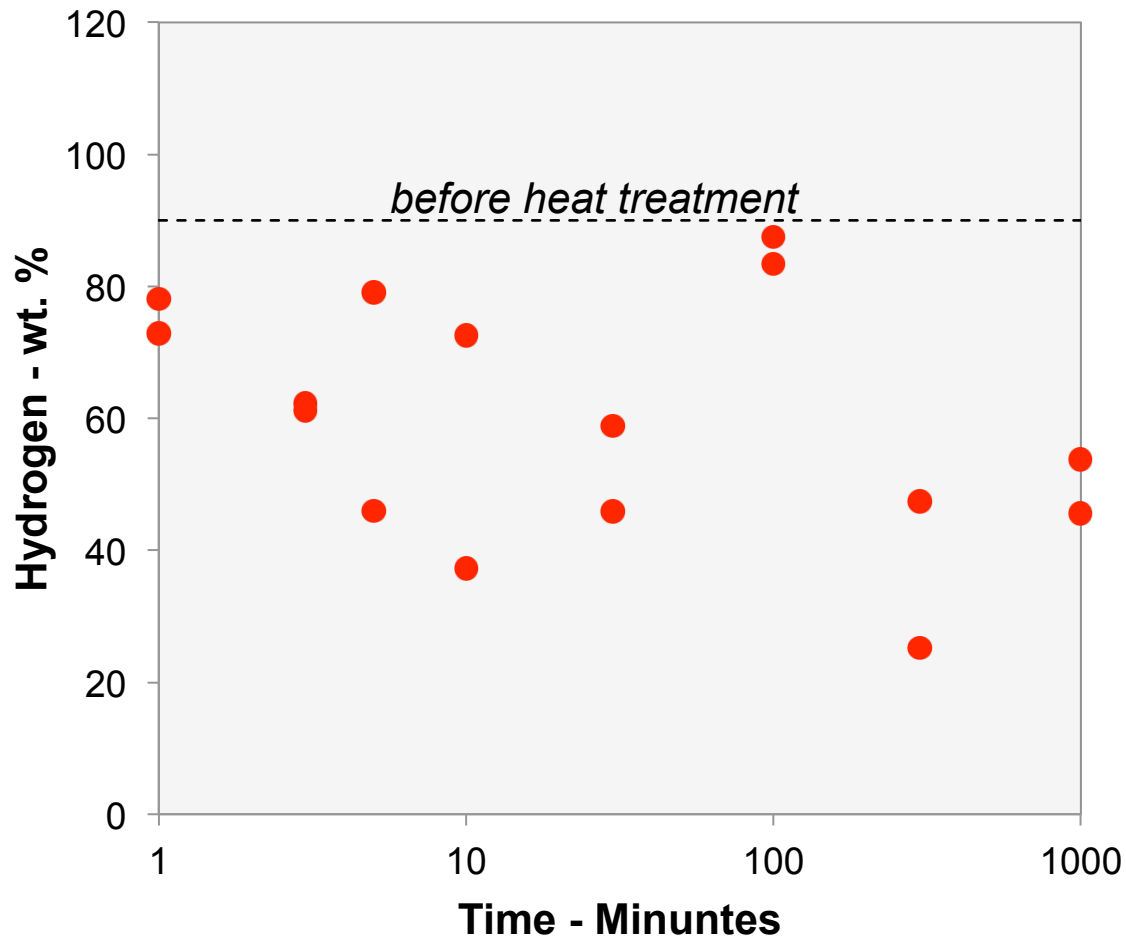


# Impact of hydrogen on RB fatigue—need to control ageing time

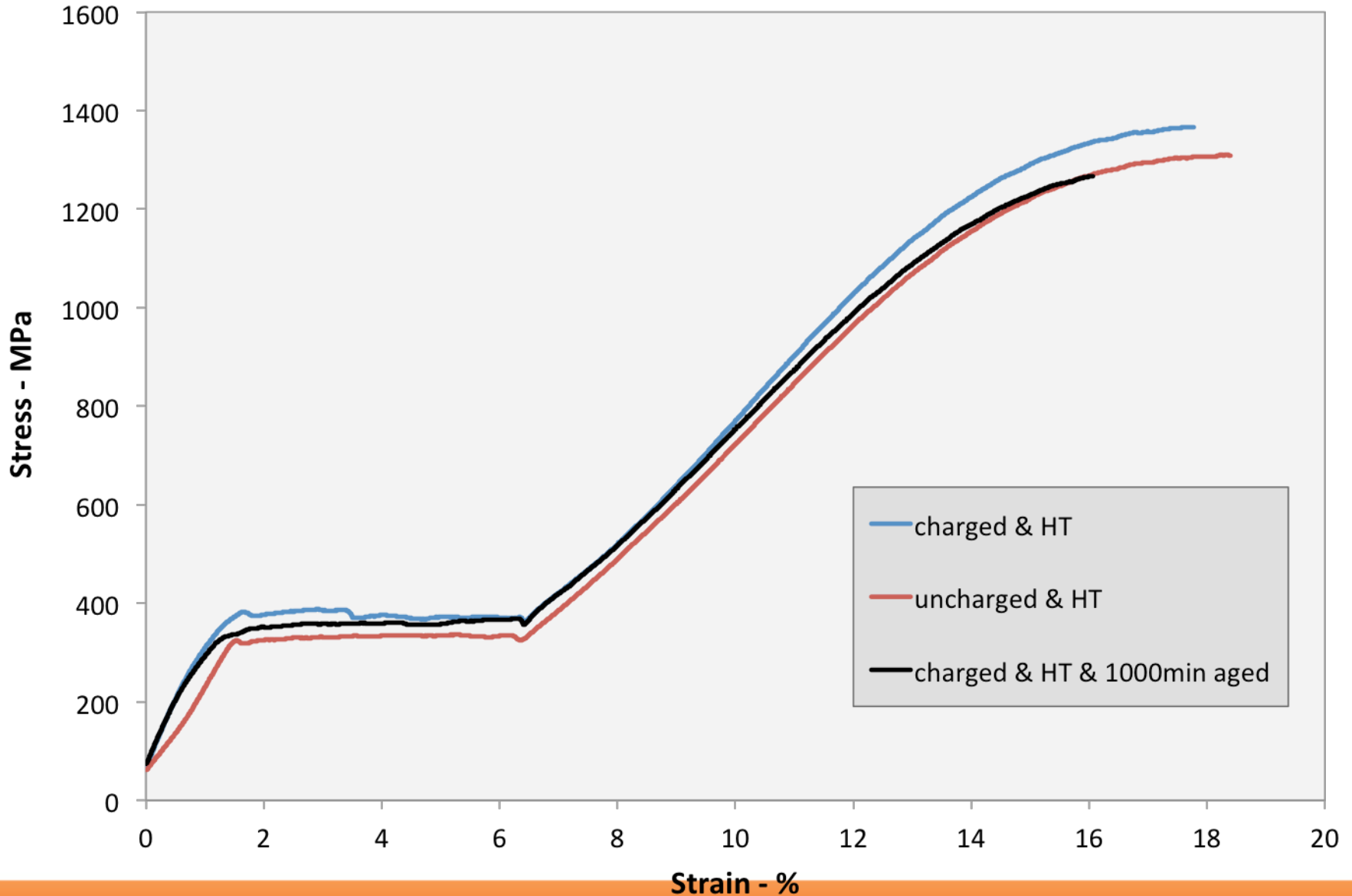




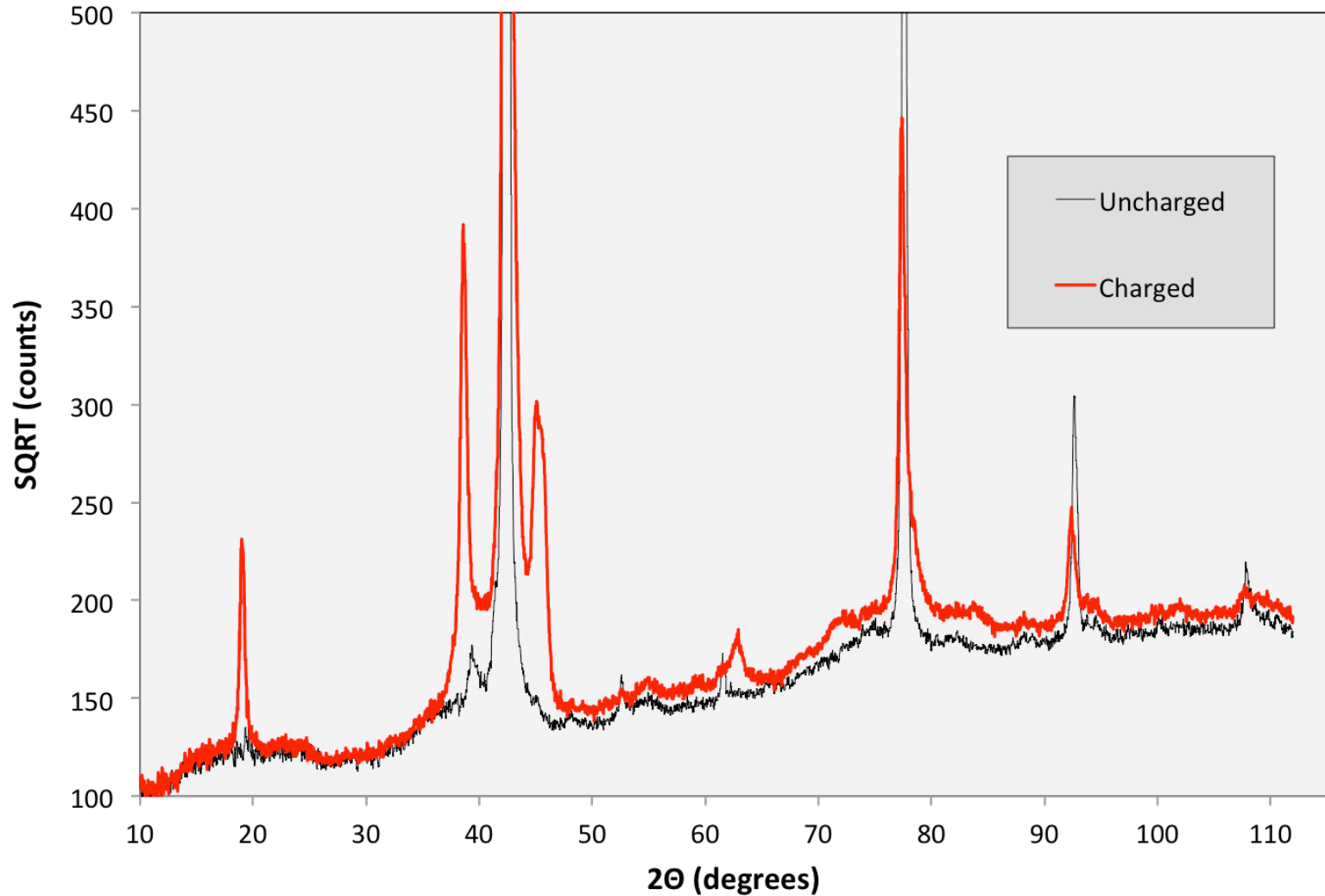
# Heat treatment (5 min at 500°C) after charging to 100 ppm



# Heat treatment after charging—appears to negate ageing effects (hydrogen levels unchanged)



# X-ray diffraction



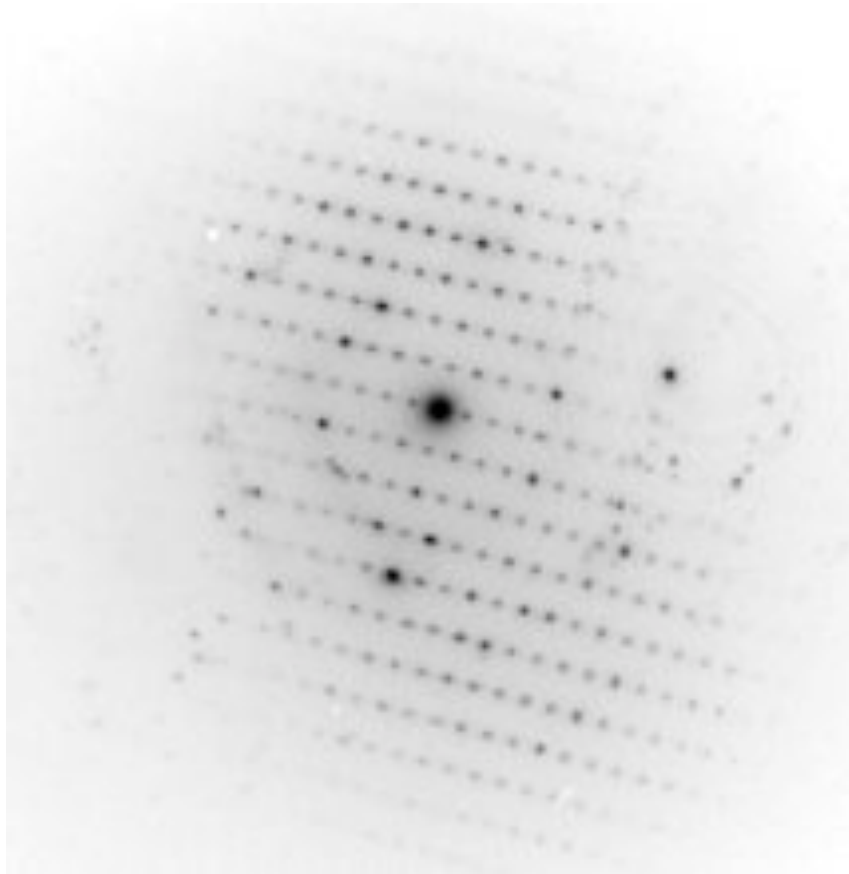
# X-ray diffraction (d-spacings in Angstroms)

<b>uncharged</b>	<b>charged</b>	<b>Pelton et al</b>
	<b>4.67</b>	<b>4.70</b>
		<b>2.38</b>
	<b>2.33</b>	<b>2.35</b>
2.13	2.10	2.14
	<b>2.00</b>	<b>2.01</b>
1.23	1.23	1.24
1.06	1.07	

*1 A. Pelton, et al, ASM Mater. Proc. Med. Dev. Conf (2003)*

## TEM-SAD:

Complicated and inconclusive, very large cell, does not appear to be cubic



## Appeal for follow-on work

- Assure that RT aging effects are taken into account in all future hydrogen studies.
- Identify hydride structure
- Measure diffusivity at RT
- Identify mechanism of RT aging (hydride formation, diffusion, congregation)
- Define more precisely the effect of HT on hydrogen and ductility