MATERION

TECH BRIEFS

# Temperature Stability of Alloy 25, Alloy 3, PerforMet™ and ToughMet® 3 Alloy up to 500°C/932°F

Many copper-based alloys depend solely on cold work or simple alloy additions to obtain their strength. What makes Materion's high performance alloys unique is the extra strength obtained through either precipitation or spinodal hardening. These hardening effects produce alloys that have the conductive, thermal, corrosion and magnetic properties of common copper-based alloys with the strength of many popular steels. However, continued exposure to elevated temperatures may alter the tensile properties of these materials. These effects are documented herein.

## PROCESS HISTORY AND AGING

Each alloy temper combination has its own unique process history of hot work, cold work and heat treatment to obtain its property set. The final heat treatment, referred to as aging, is usually responsible for most of the material's strength. Exposure to elevated temperatures will continue this aging process. Below, Figures 1 thru 3 show the general behavior during aging of Materion's most popular alloys. The specific response to elevated temperature exposure after receipt from the supplier is dependent on the material's process history and is shown on the next page.

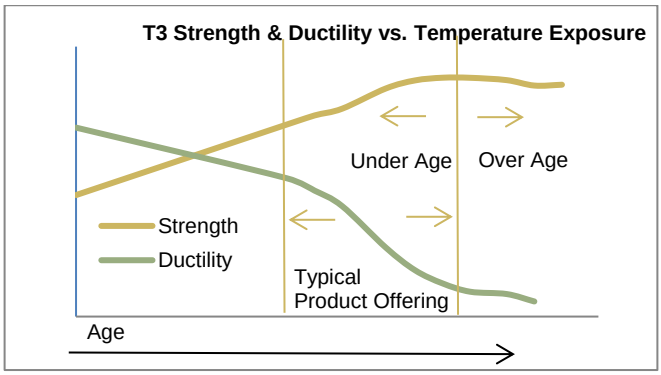


**Figure 2: ToughMet 3 gains strength as it loses ductility. After reaching peak strength, the ductility plateaus at a low value.**

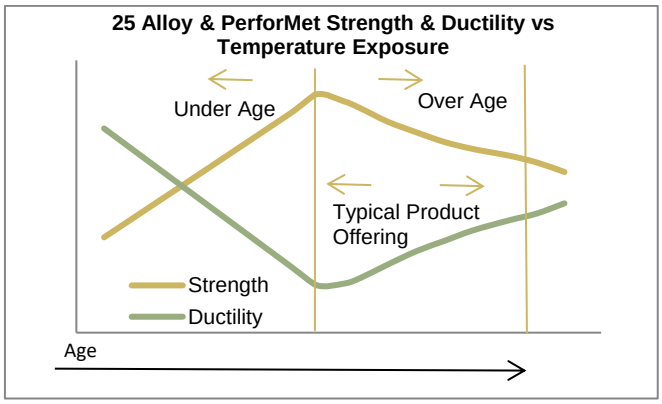


**Figure1: Alloy 25 initially gains strength and loses ductility as it ages. After reaching peak strength, it begins to lose strength become more ductile.**

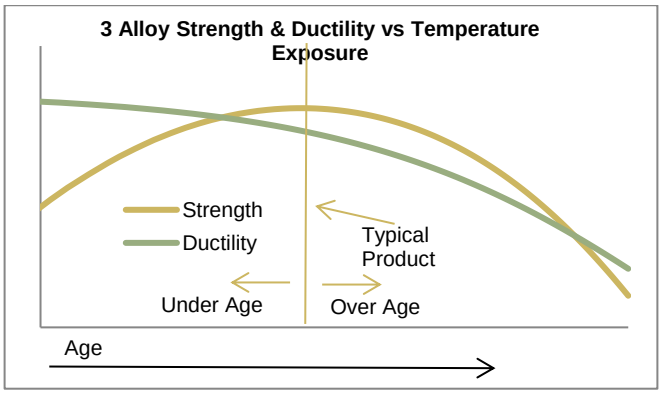


**Figure3: Alloy 3 reaches peak strength then loses both strength and ductility.**

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## EFFECTS OF TEMPERATURE EXPOSURE

Understanding and taking advantage of these aging effects allows the engineers at Materion to optimize material properties for many different applications. However, it is also important to understand these effects when considering these materials for applications at elevated temperatures. Depending on the combination of the alloy and temper, exposure to elevated temperatures could result in environmental aging. If the material was ordered at its optimal property combination for its function, this may lead to an undesirable characteristic such as reduced ductility or strength. Table 1 lists the exposure temperature at three durations at which this environmental aging will cause a 10% loss of room temperature strength or elongation (i. e. ductility).

## EFFECTS OF TEMPERATURE EXPOSURE

The graphs below Table 1 display the change in **room temperature** tensile properties of the material after exposure to elevated temperatures up to 500C for a period up to 2000 hours. The properties are presented as a factor of the mill certified properties measured before the elevated temperature exposure.

**Table1: Upper Operating Temperature Limits**

***Exposure temperature at which room temperature strength or ductility falls 10%***

| Alloy | **Temper** | **Work** | **Age Level** | **10% loss in Yield or Elongation 2hrs** | **10% loss in Yield or Elongation 20hrs** | **10% loss in Yield or Elongation 200hrs** | **Hardening Mechanism** |
|---|---|---|---|---|---|---|---|
| **3** | AT | Hot work | Peak | >370C/698F | >345C/653F | 345C/653F | Precipitation |
| **3** | HT | Cold work | Peak | >370C/698F | >345C/653F | >345C/653F | Precipitation |
| **PerforMet** | AT | Hot Work | Peak | 500C/932F | 370C/698F | 370C/698F | Precipitation |
| **PerforMet** | 1/2HT | Cold Work | Peak | 500C/932F | >370C/698F | >370C/698F | Precipitation |
| **25** | AT | Hot work | Peak | >345C/653F | 345C/653F | 300C/572F | Precipitation |
| **25** | HT | Cold work | Peak | >345C/653F | 345C/653F | 300C/572F | Precipitation |
| **25** | DST | Both | Over-aged | >345C/653F | >345C/653F | 345C/653F | Precipitation |
| **T3** | CX105 | AS-Cast | Under-aged | 300C/572F | 300C/572F | 260C/500F | Spinodal |
| **T3** | AT110 | Hot work | Under-aged | 300C/572F | 300C/572F | 260C/500F | Spinodal |
| **T3** | TS 95 | Cold work | Under -aged | 345C/653F | 300C/572F | 260C/500F | Spinodal |
| **T3** | TS120U | Cold work | Under-aged | 345C/653F | 300C/572F | 260C/500F | Spinodal |
| **T3** | TS160U | Cold work | Peak-aged | >345C/653F | 345C/653F | 260C/500F | Spinodal |

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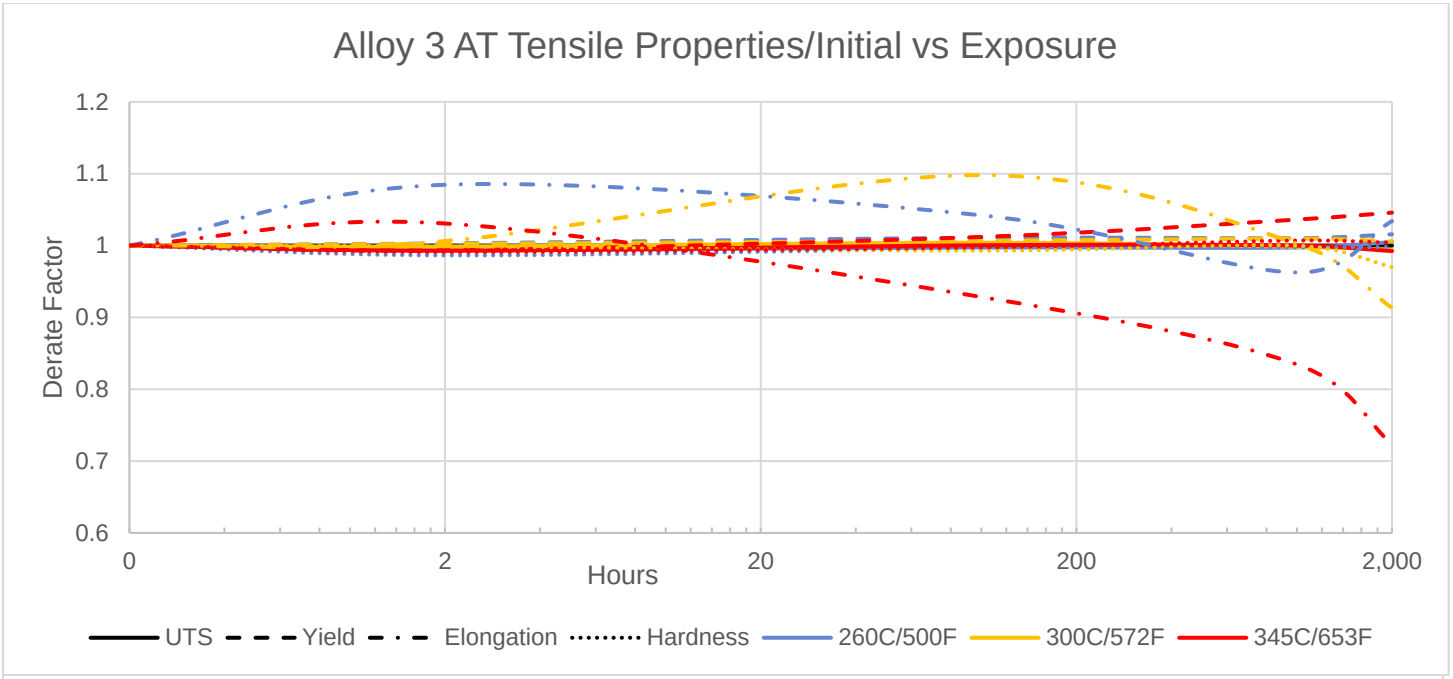


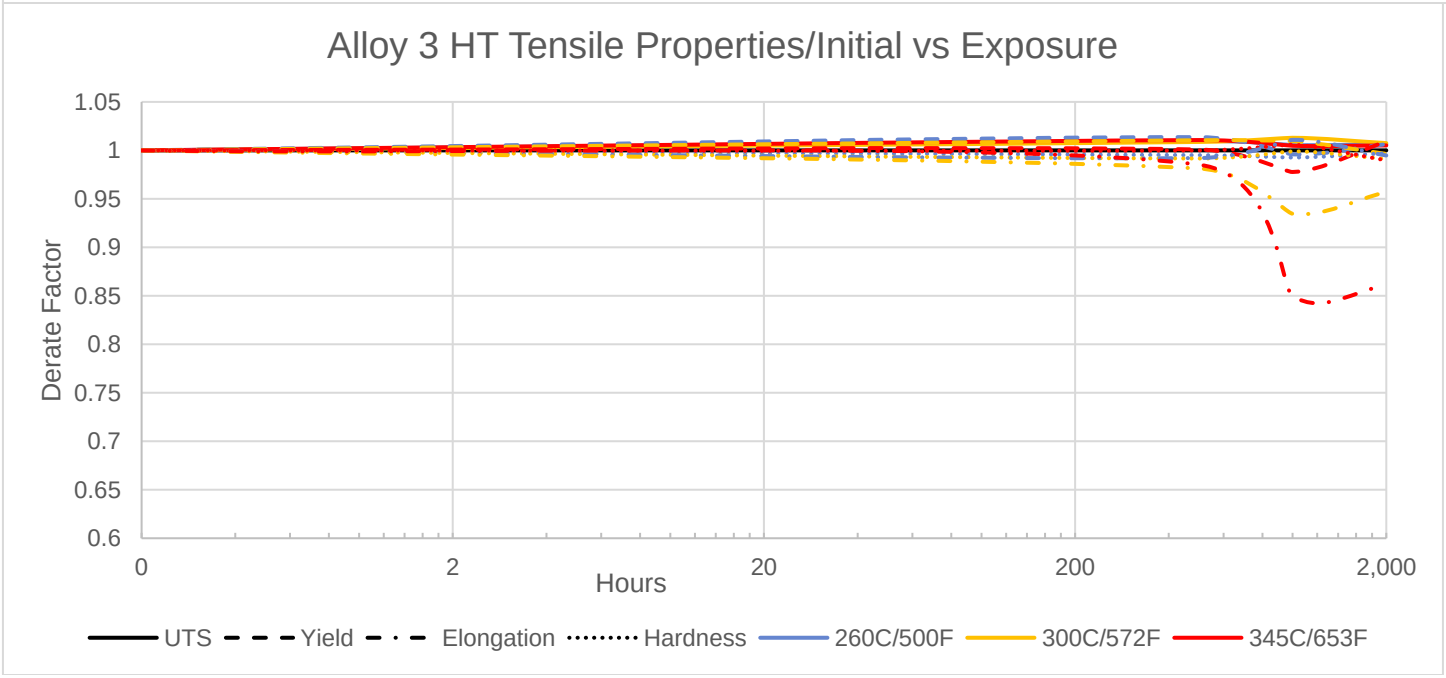


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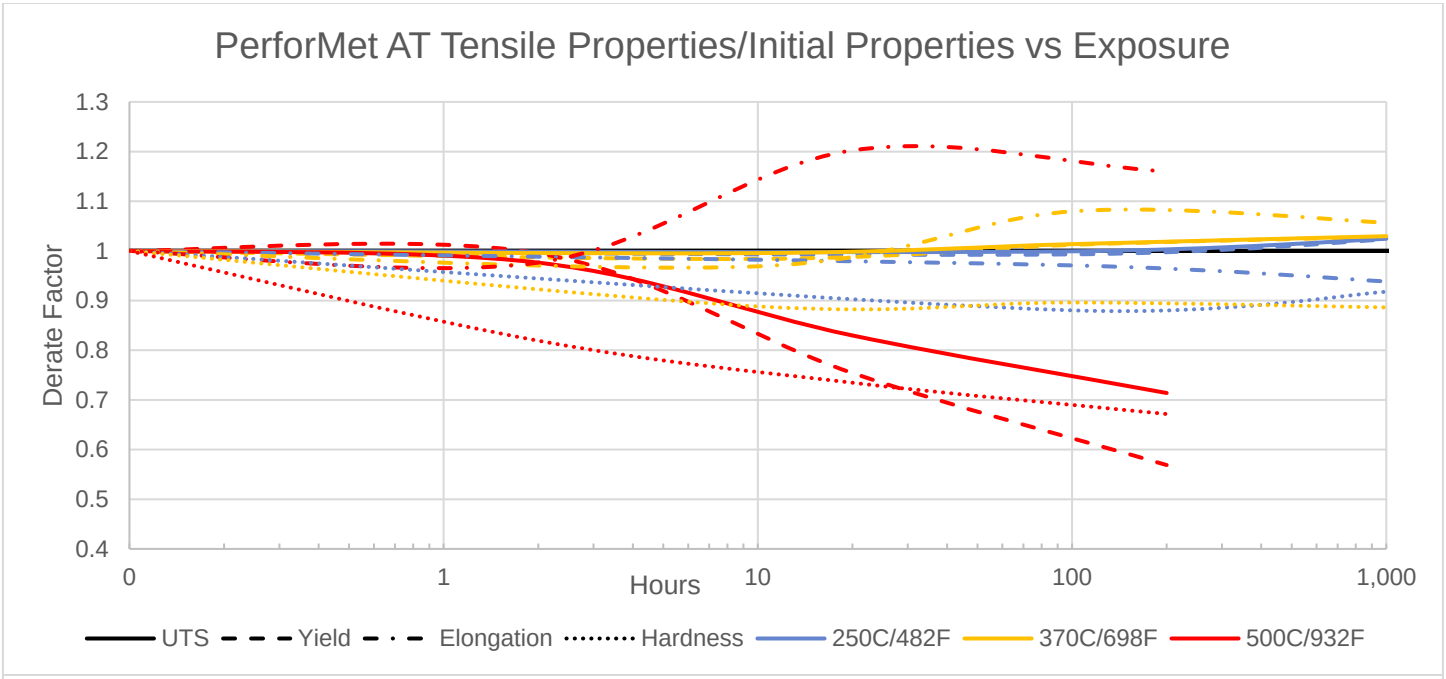


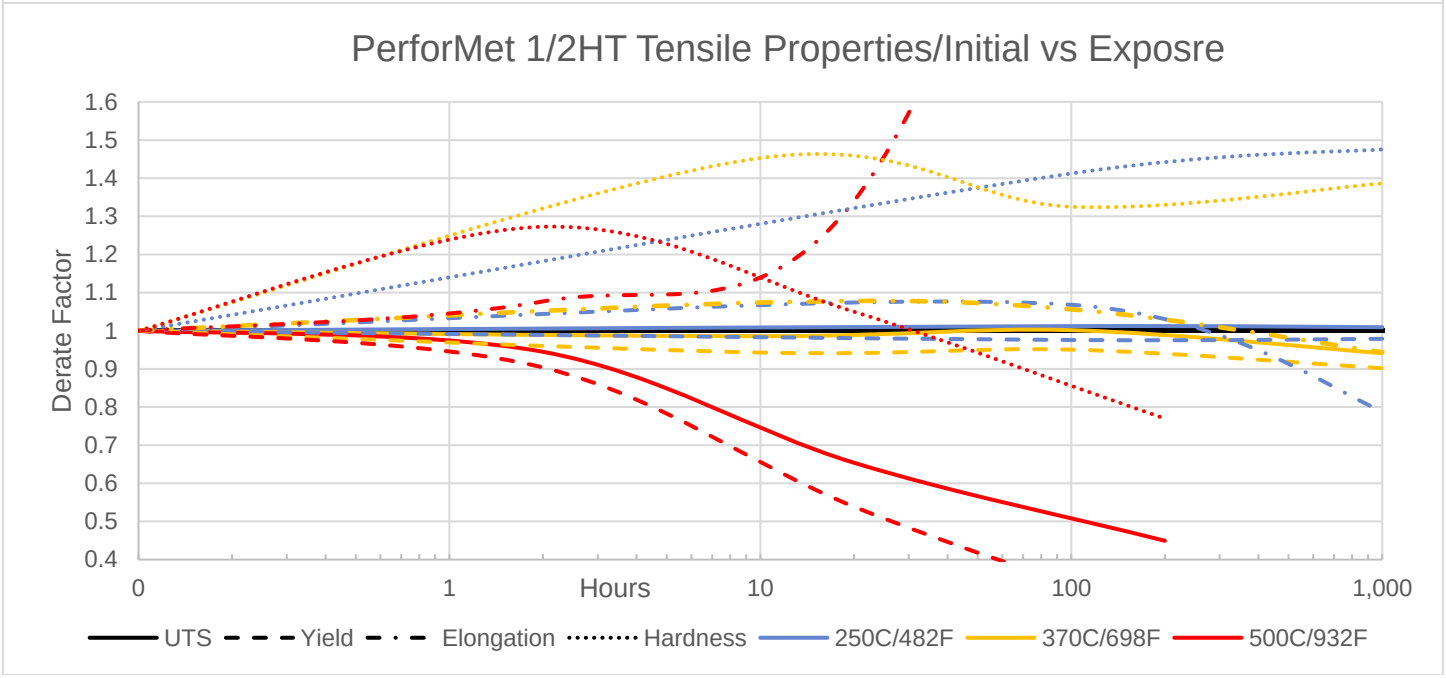


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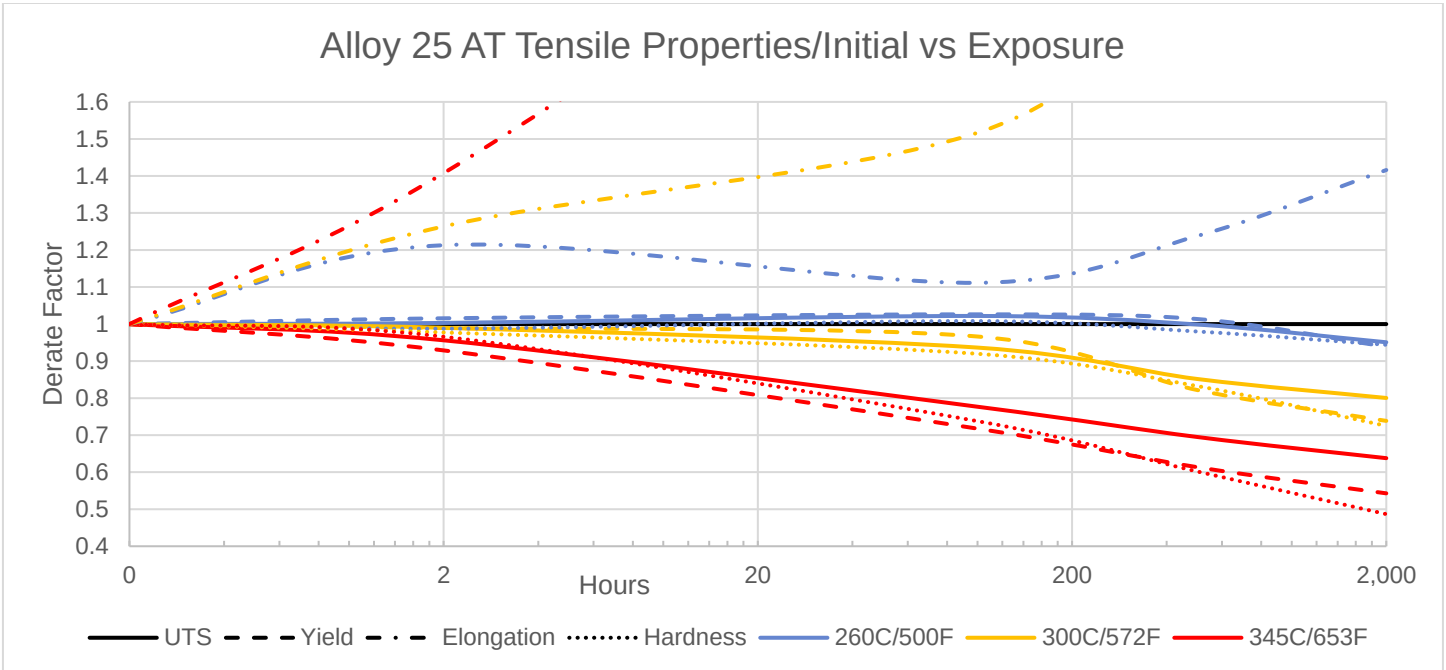


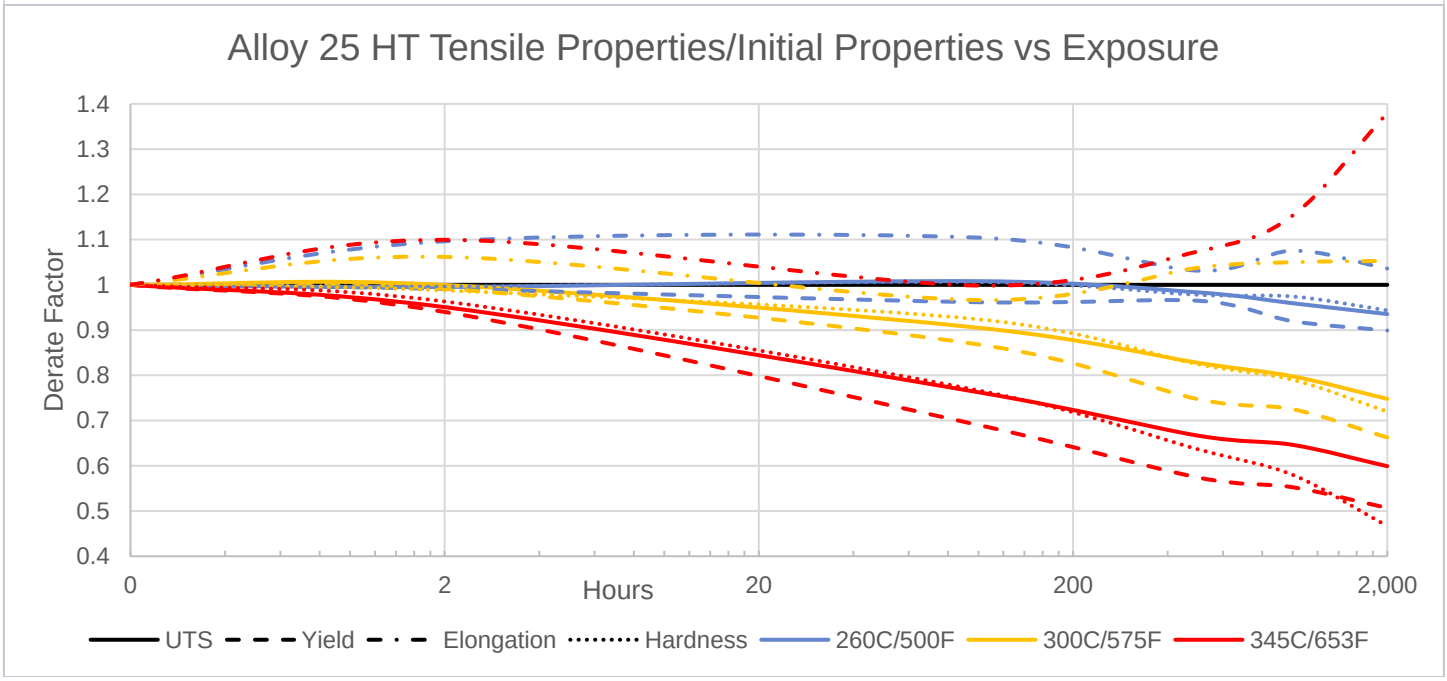


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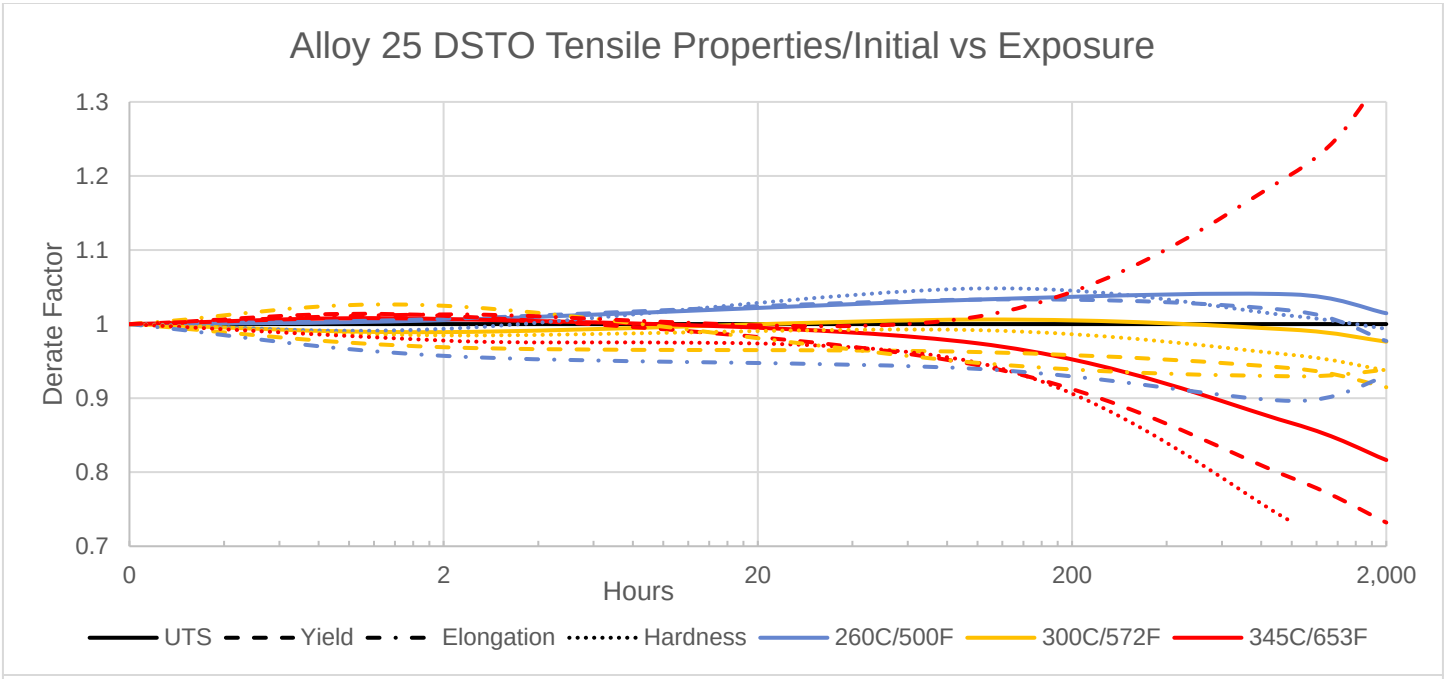


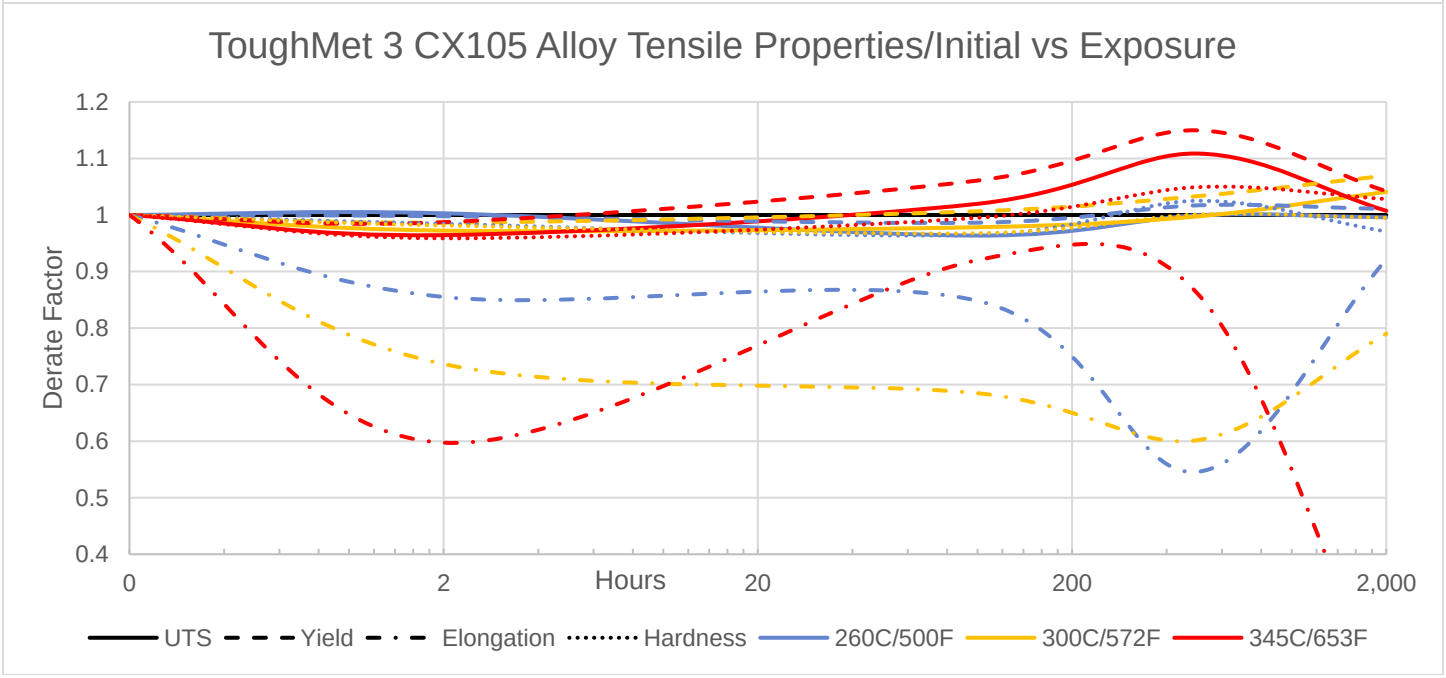


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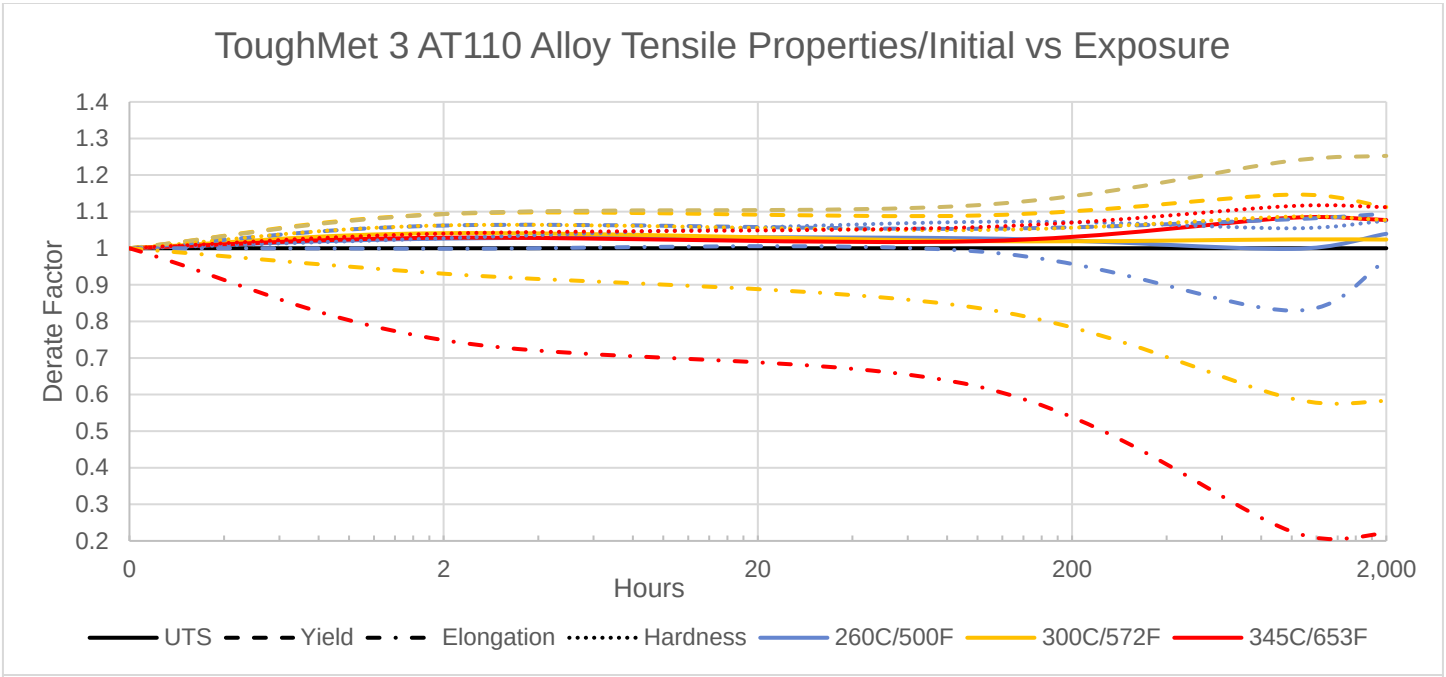


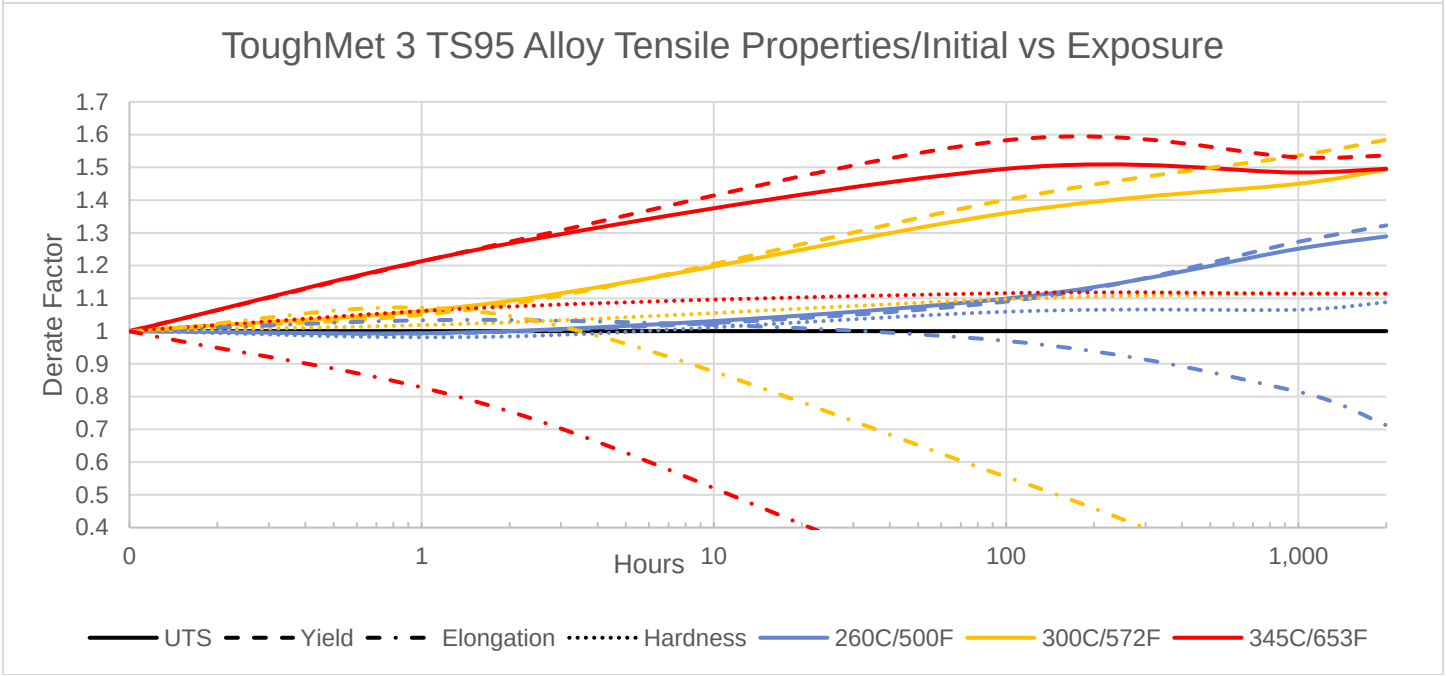


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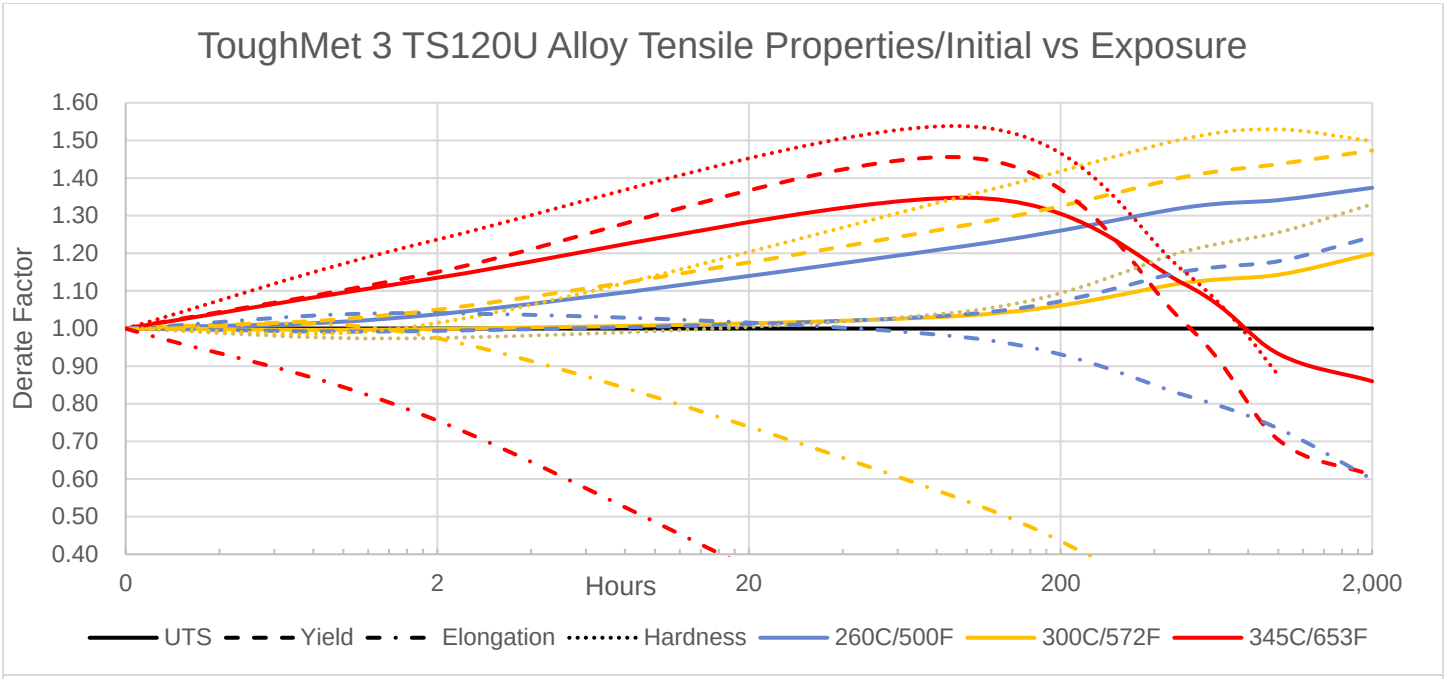


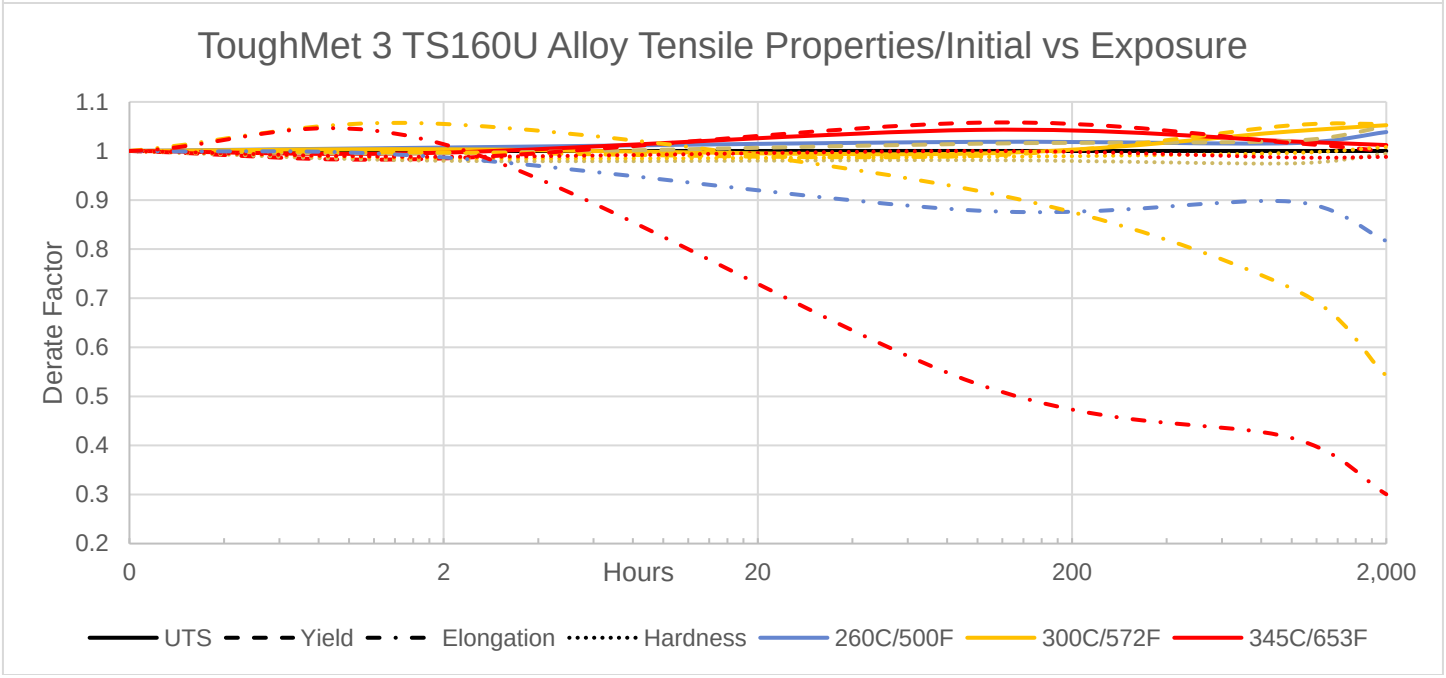


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