MSE-2: The Effect of Laser Engraving on the Mechanical Behavior of Powder Metallurgy Components

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Problem Statement:

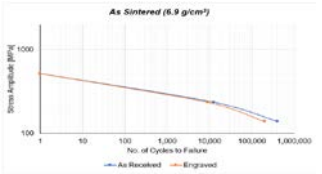
What microstructural changes does laser engraving induce in a powder metallurgy component, and how do these changes affect the mechanical behavior of the component?

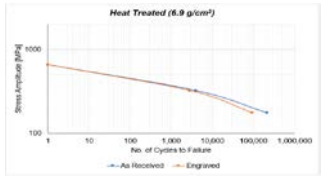
Approach:

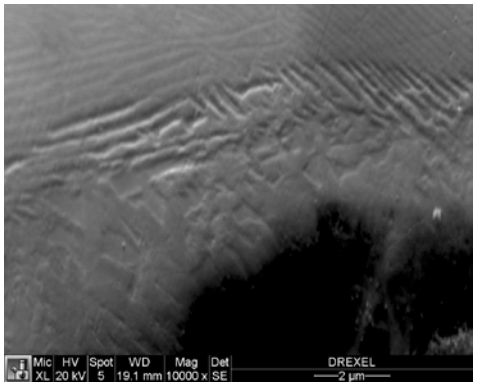
Correlated microstructural changes with mechanical properties:

- Tested engraved and non-engraved samples in static three-point bending, high-cycle fatigue, and low-cycle fatigue.
- Developed transient thermal finite element model to determine laser-induced thermal history.
- Examined engraved components *via* SEM and EBSD to characterize laser-induced phase transformations and residual stresses.

Results:







- Engraved samples had lower mechanical strength than non-engraved.
- SEM of engraved region showed evidence of rapid solidification.
- EBSD indicated solidification region was highly misoriented & strained.

Discussion & Conclusions:

- Using ANOVA and t-Test, a statistically significant difference between the as-received and engraved samples among all mechanical tests were determined.
- The thermal history from the finite element model showed an accumulation of heat as the laser traveled across the samples, leading to different microstructural changes at various points along the sample.
- Rapid solidification of melted material in the engraved region produced high local residual stresses, likely reducing mechanical performance.

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