Background/Motivation

- Nitinol (NiTi) is a Shape Memory alloy used in biomedical applications such as heart valve frames
- Non-metallic carbide and oxide inclusions limit fatigue life
- Must design device for zero probability of failure (P=0) under service conditions

Design Objectives

- Address biocompatibility by identifying compositional constraints to minimize toxicity and hypersensitivity responses
- Quantify effect of NiTi B2 matrix strength on fatigue life
- Identify B2 matrix strength necessary for P = 0 at 10^9 cycles

Methods

- A fine-scale 3D reconstruction of a single inclusion was made utilizing images from FIB/SEM serial sectioning
- FEA model utilizes crystal plasticity to predict Fatigue Indication Parameter (FIP) at different strain levels
- FIP calibrated to minimum Nf via Weibull analysis of experimental fatigue data

Conclusions

- A 50% increase in B2 matrix strength from base NiTi strength levels resulted in an increase in predicted fatigue threshold from 0.27% to 0.40% strain amplitude at 10^9 cycles
- Fatigue life increases dramatically as inclusion size decreases
- Cell cytology study indicates Pd is still a possible replacement for Ni despite cross-sensitization reports in literature