# Motivation
- Nitinol is a widely popular biocompatible SMA that has biomedical applications such as heart valves and vascular stents.
- Fatigue life is the critical performance criterion and is mainly affected by the non-metallic carbide and oxide inclusions.
- Accurately model the minimum fatigue life of the device made of these SMA’s.

# Design Objectives
- Develop an accurate finite element model based on actual 3D microstructure to predict fatigue life.
- Investigate the effect of inclusions’ size and percentage of debonding on fatigue life.
- Study the effect of inclusion type on the overall fatigue life.

# Methods
- Fine and coarse reconstruction of the 3D structure FIB/SEM images by interpolating the information from 2D slices.
- 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.

## Microstructure Reconstruction (SEM & EDS)

<table>
<thead>
<tr>
<th>Oxides</th>
<th>Oxycarbides</th>
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<td>![Oxides Image]</td>
<td>![Oxycarbides Image]</td>
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## Finite Element Simulation for Fatigue

## Calibration with Experimental Data

## Strain vs. Fatigue Life for small and large inclusion

## Fatigue Life vs. % debonding for 1% strain level

### Conclusions
- Finite element modeling predicted a 60 times increase in fatigue life for a one third reduction in inclusion size.
- The increase in Fatigue Life due to size reduction of inclusions was seen to be independent of the applied strain level.
- Increase in inclusion debonding with the matrix decreased the fatigue life till about 60% debonding.