MM3110 Assignment 6 Part-2

Ayesha Ulde
MM19B021

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1 Problem 1

The FFT file generated in DREAM.3D software for this question is in the folder $Q1$. Image of the visualised polycrystal is given below.

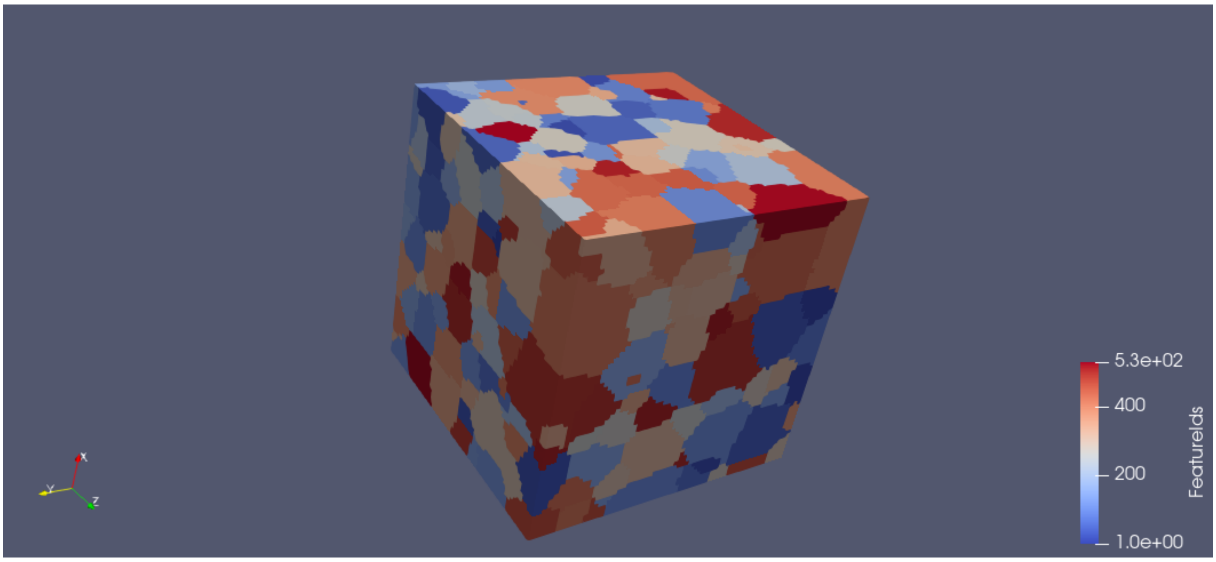

Figure 1: A 3D microstructure having a single phase, approximately 500 elongated grains and random texture generated using a $64 \times 64 \times 64$ computational grid in DREAM.3D software, as visualized in Paraview

2 Problem 2

The FFT file generated in DREAM.3D software for this question is in the folder $Q2$. Image of the visualised polycrystal is given in Figure 2.

3 Problem 3

For this question, the MATLAB source code and the FFT files generated in DREAM.3D software are in the $Q3$ folder. The output obtained for the isotropic material, Copper & Stainless Steel is visualized in the histograms and the box plots of the local stress and strain concentrations given in Figure 3, Figure 4 and Figure 5 respectively.
Based on these histograms and box plots, it can be observed that the local stress and strain distributions of an isotropic material varies over a much smaller range (1 ± 10^{-5}) whereas that of Copper and Stainless steel vary over a much larger range (1 ± 0.8). Therefore, it can be inferred that no material can be "perfectly isotropic" and even isotropic materials will have some anisotropy.

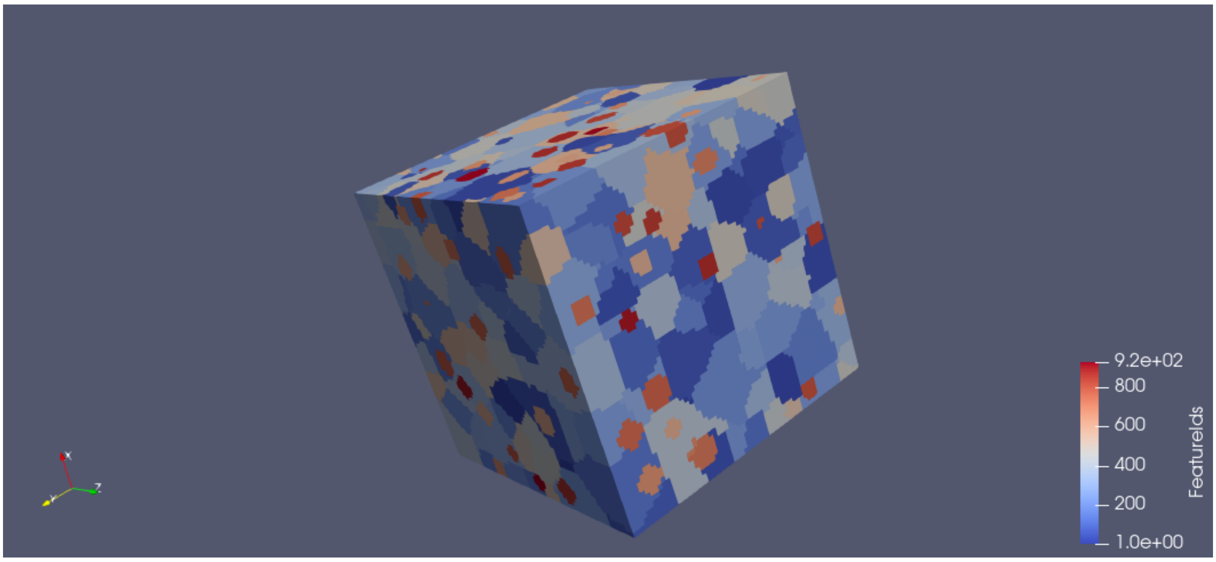

Figure 2: A 3D microstructure having a precipitation strengthened matrix with grain boundary precipitates, approximately 500 equiaxed grains (column fracction of 10%) and random texture generated using a $64 \times 64 \times 64$ computational grid in DREAM.3D software, as visualized in Paraview

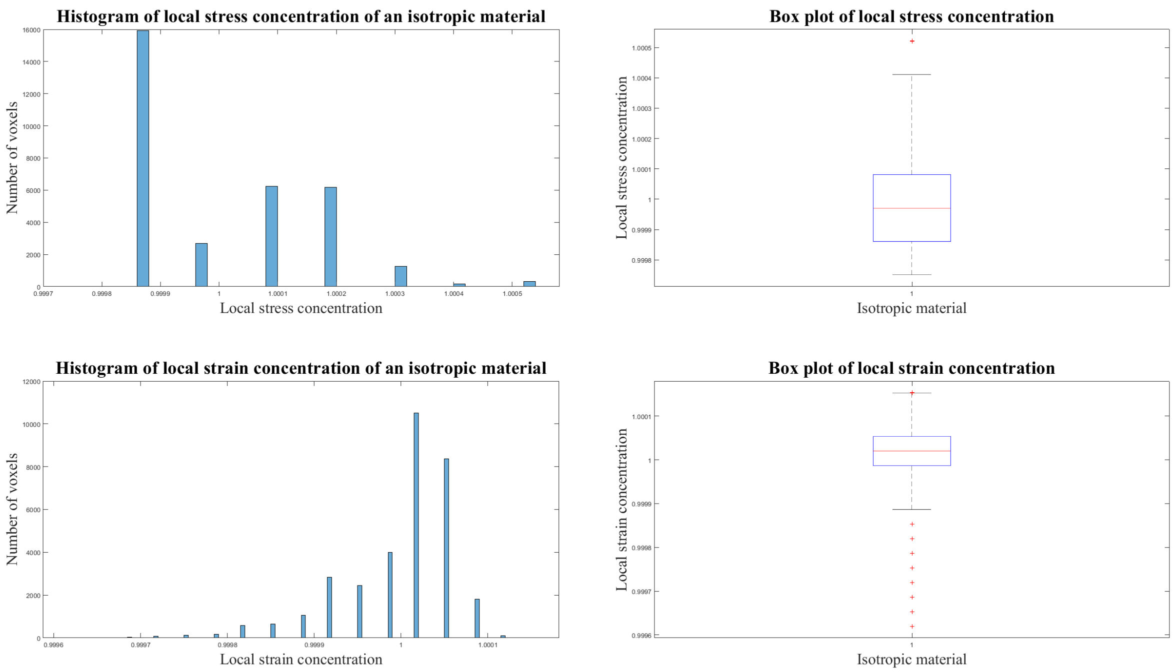

Figure 3: The histograms and the box plots of the local stress and strain concentration of an Isotropic material

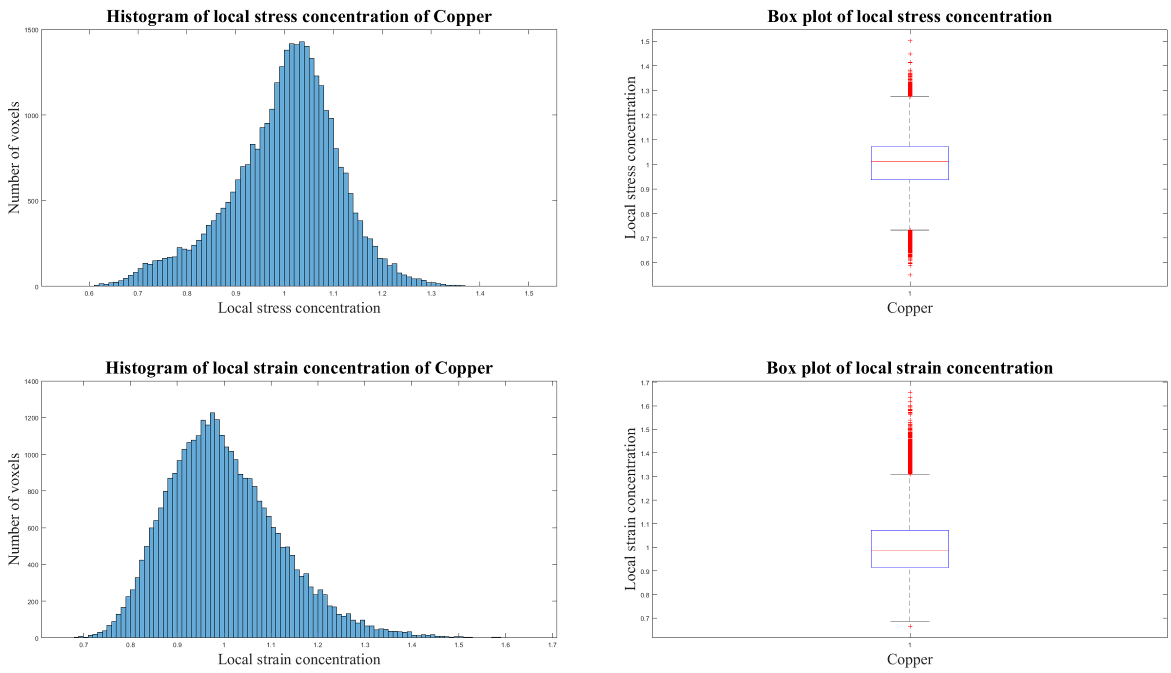

Figure 4: The histograms and the box plots of the local stress and strain concentration of Copper

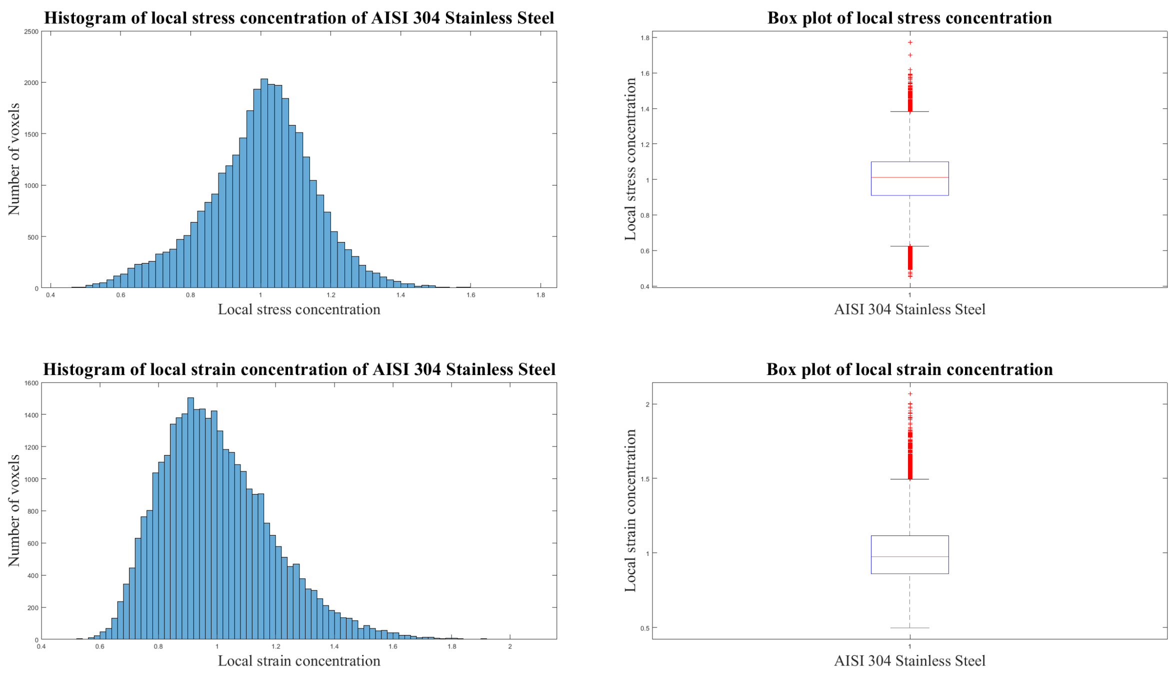

Figure 5: The histograms and the box plots of the local stress and strain concentration of AISI 304 Stainless Steel

4 Problem 4

For this question, the MATLAB source codes for FFT file generation & stress profile visualization are in the $Q3$ folder. The stress profile is given in Figure 6.

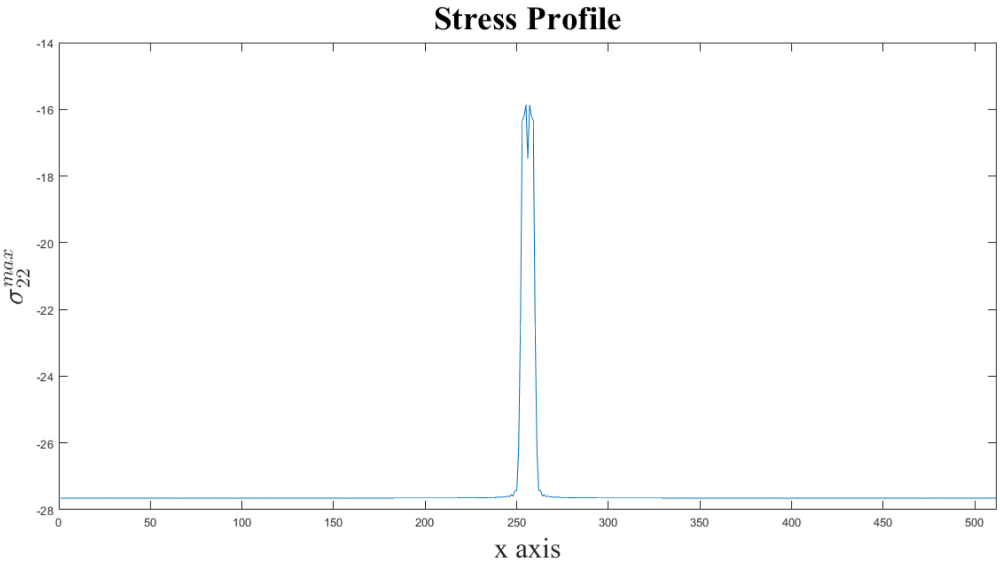

Figure 6: The stress profile from the tip of the void to the one end of the plate

The stress profile from the tip of the void to the one end of the plate is identical to that seen in front of a crack tip in fracture mechanics. In Figure 6, it can be observed that the stress is maximum at the tip of the void and decreases away from it. This in-homogeneous distribution of stress is also observed in the presence of a crack tip.

5 Problem 5

For this question, the FFT files generated in DREAM.3D software and the MATLAB source code are in the $Q5$ folder. The variation of effective elastic modulus with the fraction of second phase is given in Figure 7.
From this plot, it can be observed that as the fraction of second phase increases, the effective elastic modulus also increases.

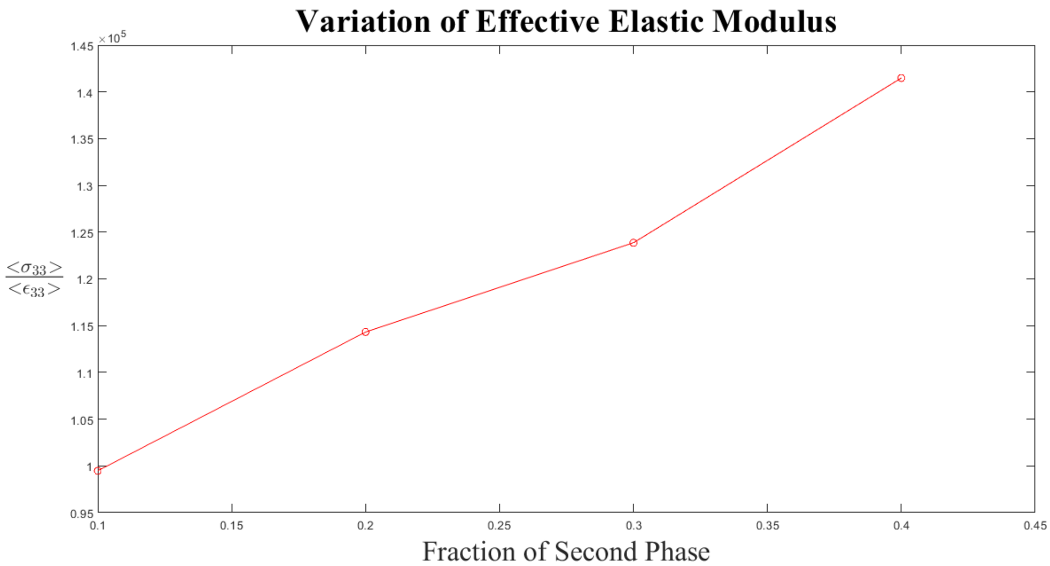

Figure 7: The variation of effective elastic modulus with the fraction of second phase. Here, the elastic stiffness tensor of the first phase and second phase were taken as that of Copper and Tungsten respectively.