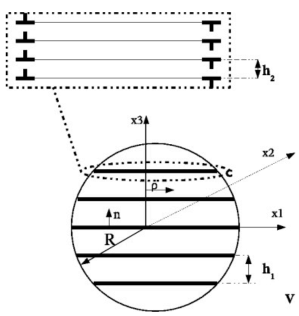
TAM 524- Project Topics   Due May 1, 2015

Choose one topic and do not exceed 5 pages (main text) and 5 figures in your report. Report should be typed. Calculations and references should be included as appendices. Findings should be summarized. Please prepare an 8 minute presentation (ppt) for the April 29 class starting at 2 pm. Please e-mail the report and the ppt file to me on or before May 1.

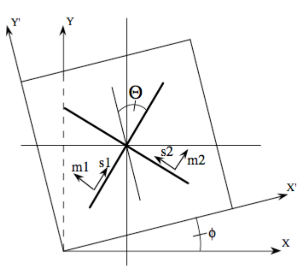
(1) Apply Mori Tanaka theorem for the case of $AlCu_2$ precipitates in an aluminum matrix that are all aligned normal to the loading axis? Determine the stress-strain response as a function of volume fraction. How accurate is this equation $\sigma = M\tau_m(1-f)+2\mu f\|\boldsymbol{\gamma}\|\varepsilon^p$ .See P. Bate, W.T. Roberts, D.V. Wilson, The plastic anisotropy of two-phase aluminium alloys--I. Anisotropy in unidirectional deformation, Acta Metallurgica, Volume 29, Issue 11, 1981, 1797-1814.

(2) Determine the evolution of the normalized elastic energy of the inclusion for clusters of dislocation loops. Reference: S. Berbenni et al. International Journal of Solids and Structures, Volume 45, Issues 14-15, 2008, 4147-4172, also see Mura p. 402.

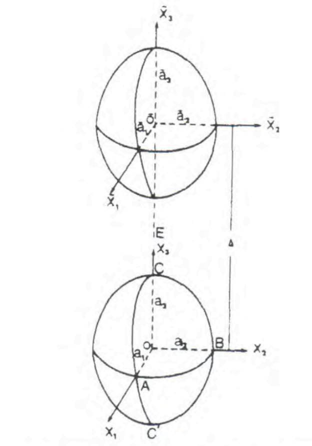


(3) Consider the "Interaction Forces due to Size Misfit" TAM 524- Lecture #10 handout. Redo the problem for the case of cubic anisotropy and cube precipitates (sides 2a,2a, 2a) instead of spherical precipitates. Determine the modified $F_{max}/(\varepsilon\,\mu\,\rho\,b)$ values as a function of normalized position? See Mura Equations 3.35-3.37 for cubic crystals case.

(4) Redo self consistent method for the case of double slip only (see class notes , Lectures #11,12) and figure below)?

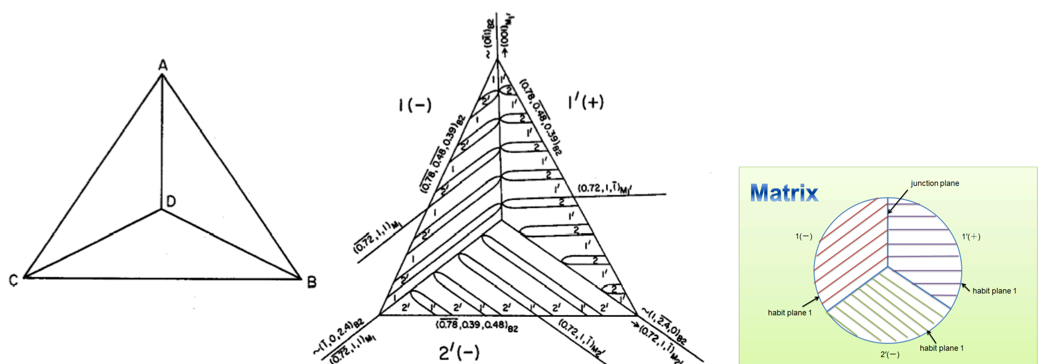


(5) Solve the problem of stress fields exterior to two inclusions as they approach each other (see p.192 Mura and Lectures #23, 24)? We are specifically interested in point A, C' and C as c_2/a is in the range 2 to 6. Compare your results with Mura. You can use zeroth order and first order (if time permits).



(6) Using Eshelby's paper (and Lecture #13) determine the shear modulus of a polycrystal made from hexagonal close packed grains? See Nye JF. Physical properties of crystals. Oxford, UK: Oxford, University Press; 1985. Compare your results with shear modulus of magnesium.

(7) Determine internal and external stress fields when the spherical martensite has three types of internal twins ? For details see: S. Miyazaki, K. Otsuka, C.M. Wayman, The shape memory mechanism associated with the martensitic transformation in Ti---Ni alloys--I. Self-accommodation, Acta Metallurgica, Volume 37, Issue 7, July 1989, Pages 1873-1884.



(8) Consider the paper by Patoor e al. that is provided as part of the journal papers and the TAM 524 class notes (Lectures # 19,20). Using the self consistent method and using the NiTi habit plane conduct a simulation of the stress-strain curves in tension and compression for randomly oriented polycrystals.

(9) Determine the external stresses of Ti-SiC (long fiber) composites under general thermo-mechanical loading? Both elastic and thermal mismatch should be considered.

Start with single fiber then determine the modification for stress fields for finite volume fractions using Mori-Tanaka theory (Lecture #16).

(10) Determine the strain temperature behavior of shape memory alloys (NiTi) under temperature cycling (see class notes, Lectures #19,20). Stress is held constant and temperature is cycled. Use random oriented crystals and self consistent method.

(11) Develop a modified self consistent theory for a polycrystalline aggregate undergoing slip and twinning where volume fraction of twins need to be tracked similar to the phase transformation case. Consider the twinning case for fcc crystals.

(12) Rederive the S_{IJKL} matrix for the case of cubic anisotropy for the case of fcc crystal. Note that the twin planes and directions are not the same as bcc (Lecture #22). The plane is {111} and the direction is <112>.

(13) Consider the determination of the habit plane in Mura's book (pp.230-231). Using the lattice constants for austenite to martensite transformation in steel, determine the habit plane (Equation 26.21)?

(14) Determine the transformation toughening associated with volume change at the crack tip as outlined by McMeeking and Evans (class notes). Show as McMeeking and Evans that the contribution from wake effects dominate the reduction of stress intensity as opposed to the contribution from material ahead of the crack tip.

(15) Consider Equation 17.27 in Mura for the Eshelby tensor for the anisotropic case. For hexagonal crystals the Green's functions are given by 17.30 and 17.31. We consider the case of a dilatational eigenstrain in a sphere in a hexagonal crystal. Determine the constraint strains (dilatational) for this case and compare it with the cubic and isotropic crystal cases given in class notes (Lecture #21).

(16) A project of your choice after consultation with me (see me for details).