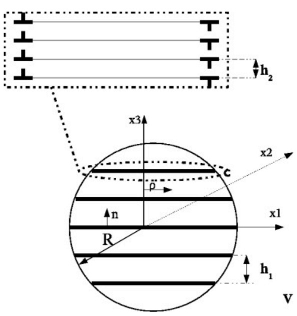
TAM 524- Project Topics   Due May 1, 2017

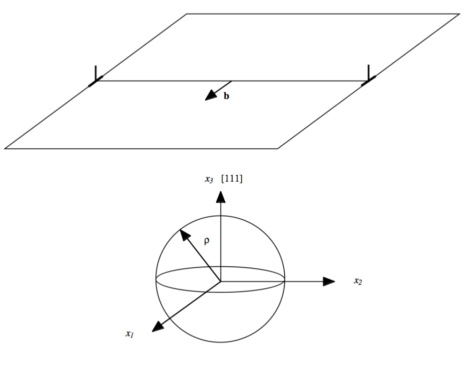
You need to work individually, this is not a group project. Do not exceed 5 pages (main text) and 5 figures in your report. Report should be typed. Calculations and references should be included as appendices (Max. 3 pages). Findings should be summarized in capsule form. Please prepare a 5 minute presentation (ppt) for the May 1st class starting at 2 pm. Please e-mail the ppt file and report to me by 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 $\sigma = M\tau_m\left(1-f\right)+2\mu f\left\|\boldsymbol{\gamma}\right\|\varepsilon^p$ .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.

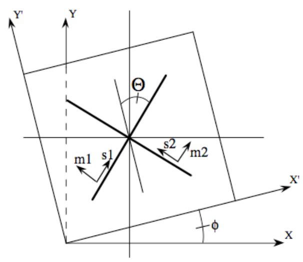
(2) Determine the evolution of the normalized elastic energy of the inclusion for clusters of dislocation loops. Reference: S. Berbenni et al. International Journal of Solids and Structures, Volume 45, Issues 14-15, 2008, 4147-4172, also see Mura p. 402. What is the displacement field that such a series of loops produces (inside and outside the slipped region)?



(3) Consider the "Interaction Forces due to Size Misfit" TAM 524 class notes (Lectures 12-13). Redo the problem for the case of hexagonal anisotropy. Determine the modified $F_{max}/(\varepsilon\,\mu\,\rho\,b)$ values? See Mura Equations for hexagonal crsytals case.

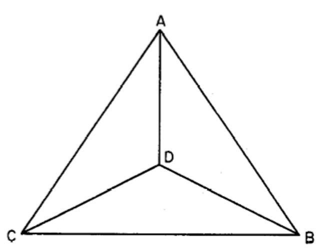


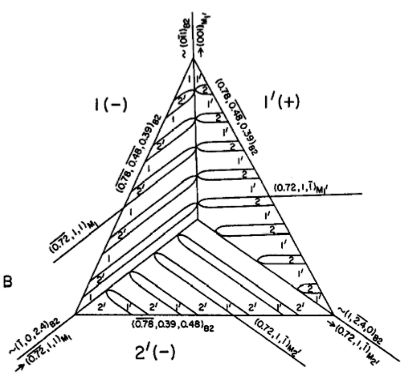
(4) Redo self consistent model for the case of double slip only (see class notes and figure below) with different levels of strain hardening? Draw the yield surfaces emanating from this case?

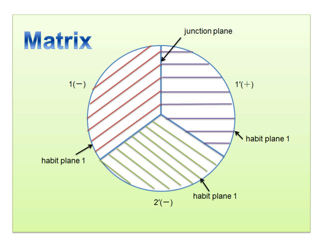


(5) Using Eshelby's paper (handout in class and utilizing the ideas in Homework #3) determine the shear modulus of a polycrystal made from hexagonal close packed grains? See Nye JF. Physical properties of crystals. Oxford, UK: Oxford, University Press; 1985. Compare your results with shear modulus of magnesium.

(6) 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.







(7) Consider the role of solute segregation to dislocations in a pileup. Determine the equilibrium spacing and the stress fields associated with dislocations and solute atoms in the pileup? Start with Equilibrium of linear arrays of dislocations Eshelby, J.D.; Frank, F.C.; Nabarro, F.R.N. Philosophical Magazine, v 42, n 327, p 351-364, Apr, 1951.

(8) 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.

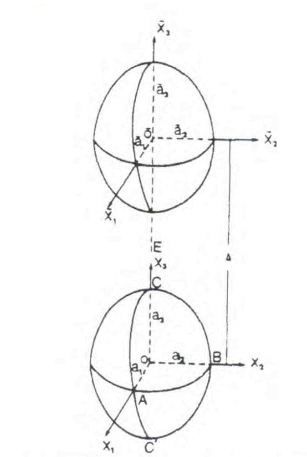
(9) Determine the strain temperature behavior of shape memory alloys (NiTi) under temperature cycling (see class handout). Stress is held constant and temperature is cycled.

(10) Rederive the S_{IJKL} matrix that is in Kumosa's paper for the case of cubic (B2 crystal) anisotropy for {114} twinning and also {112} twinning in NiTi? Which case has higher strain energy and is the one more likely to occur?

(11) 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)?

(12) Find two examples of the alternative method for determining the external stress fields ((p.187 Mura) and present these two cases.

(5) Solve the problem of stress fields exterior to two inclusions as they approach each other (see p.192 Mura and Lectures #22-23)? 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. Use first order solution.



(12) Consider the paper by Patoor e al. that is provided as part of the journal papers and the TAM 524 class notes (Lectures # 24-25). Using the self consistent method and using the CuZnAl habit plane conduct a simulation of the stress-strain curves in tension and compression for randomly oriented polycrystals.

(13) Determine the transformation toughening associated with volume change at the crack tip as outlined by McMeeking and Evans (class notes, Lectures 26-28). 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.

(14) 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 #14).

(15) We are interested in an article written by Mura in Mechanics Research Communication,Vol.24,No.5,pp.473--482, 1997. He showed that polygonal star shape inclusions also have a uniform elastic field. Show whether this analysis is correct or not by revisiting this problem?

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