Mechanical behavior of materials

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Dislocation Model for grain Boundaries

Namaskar phir se swagat karta hoon aapka is course mein mechanical behavior of materials jo ki hum hindi mein padhenge last part mein humne grain size strengthening ya Hall-Petch strengthening ke baare mein padha tha is part mein hum jaanenge ki grain boundaries kya hoti hai aur dislocation models kya hote hain main jab grain boundaries ko define karne ki koshish kar raha hoon sabse pehle main jab grain boundaries ki baat karta hoon to humne padha tha ki low angle grain boundaries hoti hai jab angle of misorientation aur angle of misalignment less than fifteen degrees Hai agar bada hai fifteen degrees Se to hum usko high angle grain boundaries kehte hain abhi hum kuch dislocation models dekhenge jo ki hum low angle grain boundaries ke liye dekhenge yaani jo angle of misalignment hai wo less than fifteen degrees Hai to ye jo do boundaries hain main inko is tarah se consider kar sakta hoon ek Pure Tilt aur Pure Twist to pure tilt boundary kya hoti hai to maan lete hain ki mere paas kuch is tarah se grain hai uska orientation is tarah se aur is plane ko main maan leta hoon ye mera boundary plane hai aur iske hisaab se agar main dekhunga ki dusra grain hai yeh kuch is tarah se tilted hai to aap dekh paa rahe honge ki is boundary plane ke hisaab se yeh dono grain is tarah se tilted hai is type ka boundary isko main kehta hoon pure tilt main kuch is tarah se bhi consider kar sakta hoon mere paas kuch is tarah se ek grain hai aur dusra grain kuch is tarah se to in dono ke beech mein jo plane banega jo boundary banegi us boundary ko main kehta hoon pure twist to aap is tarah se samajh sakte hain pure twist ko aap is tarah se bhi samajh sakte hain jaise main agar ek crystal is tarah se nikaal raha hoon aur dusra crystal main kuch is tarah se nikaalunga aap dekh paa rahe honge ki yeh dono crystal ek dusre ke upar hai to yeh jo boundary banegi yahan pe ye meri boundary pure twist kehlayegi aur yahan par yeh pure tilt hai to pure tilt boundaries kuch is tarah se define ki jaati hai jab main dislocation models ki baat karunga to ye stacking of Pure Edge dislocations is tarah se main baat karunga aur pure twist mein main consider karta hoon Screw dislocations ke dwara yeh jo boundary hai main usko screw dislocation ke dwara explain karta hoon to main abhi tilt boundaries consider karunga dislocation model ke liye to yeh model hai Symmetric Tilt Low Angle Grain Boundary ke liye to aap dekh paa rahe honge ki yahan pe ek ye grain hai aur yahan pe beech mein ek boundary hai boundary yaani yahan pe koi order nahi hoga par yahan pe humne is boundary ko represent kiya hai dislocations ke dwara main consider kar sakta hoon jab main orientation change maan ke chal raha hoon yahan pe ek grain hai yahan pe dusra grain hai aur ye jo boundary hai yahan pe main consider kar sakta hoon ki kuch extra half planes hai is tarah se yahan pe aap dekh paa rahe honge to main ek stacking of positive edge dislocations ya edge dislocation ka stacking is tarah se consider kar sakta hoon ye mera grain one ho gaya ye grain two ho gaya aur inke beech ka jo angle of misorientation hai ye theta hai ye maan lete hain mera Burgers vector hai kuch is tarah se abhi main dekh paa raha hoon ki agar is misorientation ko mujhe define karna hai is plane ke dwara to in dono ke beech ka jo distance hai average distance agar mujhe dislocation

ka ye pata hai D to main ye misorientation angle ko define kar sakta hoon kuch is tarah se main is tarah se likh sakta hoon two sine theta by two to yahan pe aap samajh sakte hain ki ye jo symmetric tilt hai isliye main theta by two consider kar raha hoon yahan pe ye theta by two hoga aur ye bhi theta by two hoga mere grain boundary ke hisaab se ye mera grain boundary plane hoga yahan pe to yahan pe mera is tarah se grain boundary plane hoga to main isliye two sine theta by two consider karunga aur ye aa jayega mera b by D agar aap trigonometric relation yahan pe apply karenge to yahan pe aapko milega ye jo sine theta by two milega aapko b by two D abhi hum dekhenge ki ye jo theta ki value hai wo low angle hai to isliye hum maan ke chalenge ki sine theta by two approximately equal to theta by two aur aapko yeh identity aa jayegi theta approximately equal to b by D ye possible kab hai jab mera Burgers vector hum dekh paa rahe honge ki ye jo distance hai mere Burgers vector se kaafi jyada hai to ye ho jayega distance between two dislocations ya Average Distance between two dislocations to aap dekh paa rahe honge ki main ek theta yaani ek misorientation angle ko define kar paa raha hoon do cheezon se ek mera Burgers vector of material aur ek Average Distance between two dislocations.

To abhi agar hum dekhenge jaise yahan pe is plot mein dikhaya ki mera tilt angle aur D spacing is tarah se plot karunga to aap dekh paa rahe honge ki theta inversely proportional hai D se to agar mera D badh raha hai D badh raha hai to theta ghatega yeh conversely true hai jaise theta badhega to D ghatega to yahan par aap dekh sakte ho jaise jaise theta ghat raha hai ye D spacing yahan pe meri badh rahi hai ya other words mein aap ye keh sakte hain ki ye jo dislocations hai inka distance agar main kam karte la raha hoon to aap dekh paa rahe honge ki tilt angle inke beech mein jo hai wo badhega kuch is tarah se badhega to yahan pe aap dekh rahe honge main distance agar ghata raha hoon to yahan pe yeh tilt angle kuch is tarah se badhega to main ek misorientation ko define kar sakta hoon a grain boundary ke dwara jaise meri symmetric tilt grain boundary hai to main is symmetric tilt grain boundary ka structure kuch is tarah se imagine kar sakta hoon to humne yahan pe dekha ki jaise theta badhega waise D decrease hoga aur hum dekh paa rahe honge ki ye jo dislocations hai hum usko continuously decrease nahi kar sakte inka distance kyunki jab ye dislocation ek dusre ke upar overlap karenge tab ah yeh possible nahi hai kyunki same nature ke dislocation hai to ek fixed distance hi yahan pe hum dekh payenge ki ek dusra slip plane yaani upper slip plane tak hi hum usko le le aa payenge to ye jab dis distance main kam karte jaunga to wahan pe dislocation ke Core Overlap hona shuru ho jayenge to ye model mere high angle grain boundaries ke liye valid nahi hoga kyunki yahan pe dislocation cores overlap hona shuru honge to isliye hum isko low angle grain boundaries tak hi seemit rakhte hain abhi hum dekhenge ki yeh jo dislocation model hai iska implication kya hai to hum dekh paa rahe hain ki mera jo low angle grain boundary hai aap dekh aap khud calculate kar sakte hain humne dekha hai ki theta ye equals to b by D hai to D main continuously decrease nahi kar sakta hoon to theta ki ek fixed value ho jayegi aur is iske value ki wajah se hum D ko ghata nahi sakte isliye hum low angle grain boundary aur high angle grain boundary mein difference kar sakte hain ye theta ki ek value hum fixed kar sakte hain ye fifteen degrees Aap calculation karke dekh sakte hain ki wahan tak fifteen degrees Tak ye D value hum ghata sakte hain to abhi hum dekhenge ki jab main angle of misorientation plot kar raha hoon aur grain boundary energy plot kar raha hoon to aap dekh paa rahe honge ki jaise jaise angle of misorientation badh raha hai waise waise ek grain boundary energy bhi badh rahi hai par ek samay tak woh linear hai wo close to fifteen degrees Tak linear rehti hai uske baad wo change ho rahi hai aur ye meri saari high angle grain boundaries hain to ye meri low angle grain boundary ho gayi aur ye saari high angle grain boundaries ho gayi aap dekh paa rahe honge ki ye yahan pe kuch yahan pe kuch Special Boundaries hain aur special boundaries ko yaani jaise Twin Boundary hai to yahan pe unki energies thodi kam hoti hai kyunki woh special boundaries hai yahan pe kuch atomic structures coherent ho jaate hain ah unke orientation ki wajah se isliye grain boundary jo hoti hai coherent ho sakti hai aur uski energy kam rehti hai unko hum

special boundaries kehte hain jaise ki twin is course mein hum in grain boundaries ke baare mein nahi padh rahe to ye just aapke introduction ke liye hai to mere paas low angle grain boundary hai aur high angle grain boundary hai to agar main schematically plot karu gamma jaise mere grain boundary energy hai milli Joules per meter square aur theta jo misorientation angle hai uske dwara to mujhe kuch is tarah se relation milega aur ye hogi meri low angle grain boundary aur yahan par hum dekhenge ki grain boundary energy jo hai woh linearly increase hoti hai aur yahan par jo high angle grain boundary hai yahan ki energy more or less constant hogi ho jayegi aur a kuch special boundaries ke liye ye ghat-ti hai but majority of high angle grain boundaries ke liye ye is tarah se constant ho jaati hai aur yahan pe hum dekhenge ki ye jo gamma hai wo directly proportional to theta hai yaani angle of misorientation yahan pe linear relation mil raha hai par yahan pe aap dekhenge ki high angle grain boundary jo hai uski energy ek saturation value tak aayegi aur wo value hai gamma s by three ye jo meri surface energy hai a uske hisaab se aa jayegi to ye gamma meri surface energy uska one by three hum lenge to ye meri grain boundary energy ho jayegi to ek typical value yahan pe mil jayegi humein high angle grain boundaries ki agar main tilt boundary ki baat karunga jab maine tilt boundaries ki baat ki thi yahan par to tilt boundaries mein maine edge dislocations ka consideration kiya tha ye symmetric tilt boundaries thi yahan pe hum agar twist boundary ki baat karenge to ye jo model hai twist boundaries ka ye a screw dislocations ke dwara explain kiya jaata hai ye aapke information ke liye aap kuch aur text book padh sakte hain ki ye kis tarah se model define hota hai aur aur ye jo grain boundary energy hai is model ke dwara kis tarah explain ki ja sakti hai abhi jab main polycrystalline material ki baat karta hoon aur grain boundaries ki baat karta hoon to yahan par hum do type ke dislocation dekhenge ek Statistically Stored Dislocations aur ek Geometrically Necessary Dislocations ye do concepts important hai jab main polycrystalline materials ko deform karta hoon.

To maan lete hain mere paas kuch teen grains hai is tarah se ek polycrystalline material mein aur main in grains ko yahan pe deform karta hoon yaani is tarah se kuch ah force apply karunga to ye teen grains yahan pe deform honge to deform kis tarah se honge humne dekha tha single crystal mein jo jo grain jispe sabse jyada highest Schmid factor reach karega is tensile axis ke wajah se wo hum dekhenge a wo grain pehle deform hona shuru karega agar hum dekhenge ki teen grain individually deform karna chalu kare to kis tarah se deformation hoga to jab hum deform karenge to yahan pe pehle dislocations generate honge aur ye dislocations move hoke yahan pe grain jo hai wo deform hoga aur deform hoga kuch is tarah se maan lete hain ye grain jispe highest Schmid factor tha ye pehle deform hona chalu kiya phir ye independently deform ho rahe hain ye case tab hai jab yahan pe ye teenon grains independently deform ho rahe hain to aapke paas dislocation to milenge in teen grain mein aur yahan pe grain boundaries jo hai wo kuch is tarah se overlap hogi ya yahan pe kuch Voids taiyaar honge to deformation agar Schmid law ke according hai aur ye teenon grains independent hai deformation ke liye tab humein overlaps aur voids milte hain to yahan par main likh leta hoon yeh overlaps hai aur yeh jo hai ye voids hain par hum jab dekhte hain polycrystalline material ka deformation yaani atleast hum ultimate tensile strength tak jab jaate hain tab humein koi voids ya overlaps nahi milte hain wahan pe hum dekh sakte hain ki ye teenon grains yaani inki boundaries intact rehti hai yaani hum keh sakte hain ki strain yahan par accommodate ho jaata hai Shape Change ke dwara to agar is tarah se deformation nahi mil raha hai humein overlaps aur voids nahi mil rahe hain aur humein actually is tarah se deformation milta hai yahan pe strains accommodate ho jaate hain shape change ke dwara to aap dekh paa rahe honge ki ye jo region hai yahan pe kyunki yahan pe orientation alag hai yahan pe orientation alag hai yahan pe strain accommodate hota hai aur wo jo accommodate hota hai wo hum dekhenge kis tarah se accommodate hota hai ye jo dislocations hai jo generate hote hain during deformation inko main kehta hoon Statistically Stored Dislocation ye generally form hote hain mere deformation ke dauran aur humne baat ki thi jab yeh strain accommodation ki yahan par to yeh jo strain

accommodation hota hai yeh hum maan ke chal sakte hain yahan pe kyunki yahan pe ek Continuity chahiye humein to yahan pe ek continuity hum maan ke chalte hain yahan pe kuch dislocation generate hote hain jo ki ye geometrically continuity yahan pe maintain karte hain is dislocations ko hum kehte hain Geometrically Necessary Dislocations yeh dislocations isliye zaroori hai kyunki yeh geometrical compatibility maintain karte hain do grain ke beech mein aur yeh correct karte hain mere overlaps aur voids ko ye maine simplistic way se aapko explain kiye geometrically necessary dislocation aur statistically stored dislocation jab main dislocation density ki baat karta hoon tab main total dislocation density ki jab baat karunga to main actually ye do cheezein bol raha hoon ki usmein statistically stored dislocations hai aur geometrically necessary dislocations hain jab mera material uniformly deform ho raha hai aur grains mein geometrical compatibility hai to is part mein humne do models dekhe grain boundaries ke ek tilt boundary ke liye low angle tilt boundary wo ki symmetric tilt boundary thi jo ki humne pure edge dislocations ke hisaab se dekha hai aur ek boundary humne maine aapko define karne ke liye boli hai jo ki twist boundary hai jo pure screw ke dwara model ki jaati hai aapko aur ek exercise hum dete hain ki Mixed Boundary agar mujhe ya Mixed Grain Boundary ya mixed dislocations ke saath mujhe agar kuch boundary define karni hai to kaun si grain boundary taiyaar hogi abhi ke liye yahan pe hi rukta hoon dhanyavad