PRISMS-Plasticity

Crystal Plasticity

Simple tension example -FCC Copper

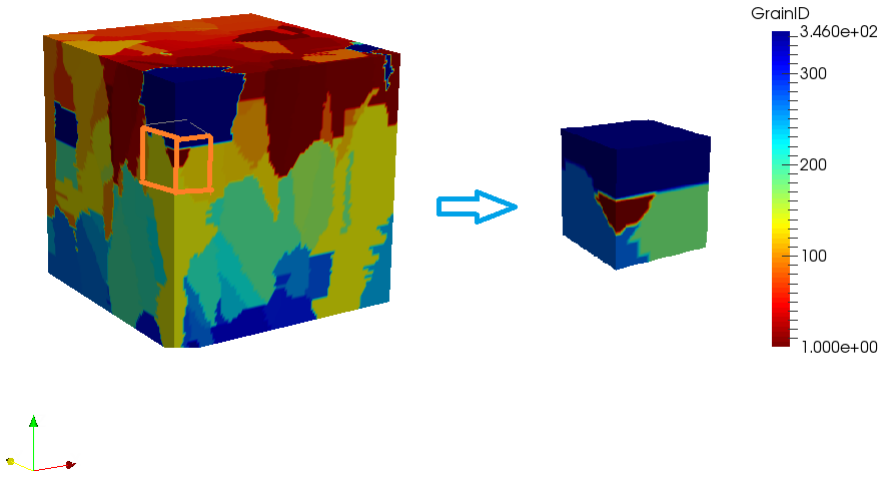

Figure 1: Input microstructure (3D Materials Atlas [2])

This is an illustrative example of a simple tension deformation problem. A vitrual fcc microstructure was tested with the material parameters of Copper which were obtained from [1]

Input Crystal Parameters-parameters.h

```
//Elastic Parameters

//Elastic Parameters

#define c11 170e3 // C11 (MPa)
#define c12 124e3 // C12 (MPa)
#define c44 75e3 // C44 (MPa)


//Crystal Plasticity parameters

#define numSlipSystems 12 // generally 12 for FCC
#define latentHardeningRatio 1.4 //q1
#define powerLawExponent 2.25 //a
#define initialSlipResistance 16.0 // CRSS s0(MPa)
#define saturationStress 148.0 //s_s(MPa)
```

```
#define initialHardeningModulus 180.0 //s_s(MPa) //h0(MPa)
```

Input Geometry Parameters

```
// In main.cc crystalPlasticity<dim>::mesh()
double spanX=1.0; //Span along x-axis
double spanY=1.0; //Span along y-axis
double spanZ=1.0; //Span along z-axis


#define feOrder 1 // Basis function interpolation order (1-linear)
#define quadOrder 2 // Quadrature point order n^3 (2->8 quadrature
    points)
#define meshRefineFactor 3 // 2^n*2^n*2^n elements(3->8*8*8 =512
    elements)
#define totalNumIncrements 100 // No. of increments

//In main.cc class BCFunction : public Function<dim>
values[0]=0.001; // displacement along X-Direction per increment


// Read Input Microstructure

unsigned int numPts[3]={20, 20, 22}; // No. of voxels in x,y and z
    directions
```

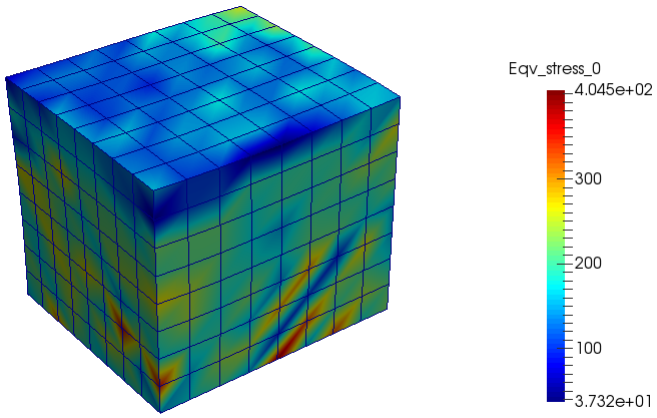

Figure 2: Equivalent Von-Mises Stress shown on a deformation field

Table 1: FCC Copper Slip Systems

System Number	Slip Direction	Slip Plane
1	[1 1 0]	(1 1 1)
2	[-1 0 1]	(1 1 1)
3	[0 1 -1]	(1 1 1)
4	[1 0 1]	(-1 1 1)
5	[-1 -1 0]	(-1 1 1)
6	[0 1 -1]	(-1 1 1)
7	[-1 0 1]	(1 -1 1)
8	[0 -1 -1]	(1 -1 1)
9	[1 1 0]	(1 -1 1)
10	[-1 1 0]	(-1 -1 1)
11	[1 0 1]	(-1 -1 1)
12	[0 -1 -1]	(-1 -1 1)

References

[1] Anand, L., and M. Kothari. "A computational procedure for rate-independent crystal plasticity." Journal of the Mechanics and Physics of Solids 44.4 (1996): 525-558.
[2] 3D Materials Atlas AL6XN+Reconstruction