

1. Determine the resolved critical shear stress for an FCC single crystal that yields when a 2 MPa stress is loaded along its $[\bar{1} 2 3]$ direction, the slip plane is $(1 1 1)$ and the slip direction is $[\bar{1} 0 1]$.
2. Metals under stress undergo plastic deformation due to what atomic-level mechanism (can be accomplished using two words)?
3. To strengthen metals, a number of approaches can be taken but they all work by what atomic-level mechanism (can be accomplished using three words)?
4. What is the stress in MPa on a fiber with diameter 25 μm subjected to an elongational load of 25 g along the fiber axis?
5. What is the ratio of grain boundary to bulk diffusion coefficients of carbon in BCC iron at room temperature (25 $^{\circ}\text{C}$) if the activation energy for bulk diffusion is 84 kJ/mol, the activation energy for grain boundary diffusion is one-half that of bulk diffusion, and both types of diffusion have the same infinite-temperature diffusion coefficient?

$D = D_0 \exp(-Q/RT)$, $R = 8.314 \text{ J/K}\cdot\text{mol}$, $\sigma = F/A_0$, $g = 9.8 \text{ m/s}^2$, $\sigma_c = \tau_{CR}/\cos\theta\cos\phi$,
vector dot product: $\mathbf{A} \cdot \mathbf{B} = |\mathbf{A}||\mathbf{B}|\cos\theta$

1. 0.933 MPa
2. dislocation motion
3. impede dislocation motion
4. 499 MPa
5. 2.1×10^7