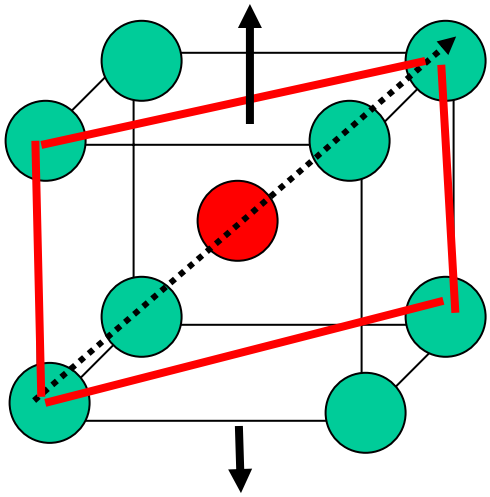
Collaborative Learning Exercise
Critical Resolved Shear Stress in NiTi
SOLUTIONS

NiTi in the austenite phase has the crystal structure shown below. Assume that a tensile test is done on a NiTi dog bone sample where the applied force is perpendicular to the family {001} planes as shown below. If the yield stress is found to be 13 MPa, calculate the critically resolved shear stress. *(Hint: sketch the slip plane and slip direction in the figure below.)*



Direction of applied stress [010]
Direction of Slip plane normal <110>
Slip direction $<\bar{1}11>$

The angle between the applied stress [010] and normal to the slip plane [110]

$$\Phi = \cos^{-1}\left[\frac{u_1u_2 + v_1v_2 + w_1w_2}{\sqrt{\left(u_1^2 + v_1^2 + w_1^2\right)\left(u_2^2 + v_2^2 + w_2^2\right)}}\right]$$

$$= \cos^{-1}\left[\frac{0\cdot1+1\cdot1+0\cdot0}{\sqrt{\left(0^2+1^2+0^2\right)\left(1^2+1^2+0^2\right)}}\right] = 45^\circ$$

The angle between the applied stress [010] and slip direction $[\bar{1}11]$

$$\lambda = \cos^{-1}\left[\frac{u_1u_2 + v_1v_2 + w_1w_2}{\sqrt{\left(u_1^2 + v_1^2 + w_1^2\right)\left(u_2^2 + v_2^2 + w_2^2\right)}}\right]$$

$$= \cos^{-1}\left[\frac{0\cdot-1+1\cdot1+0\cdot1}{\sqrt{\left(0^2+1^2+0^2\right)\left((-1)^2+1^2+1^2\right)}}\right] = 54.7^\circ$$

$$\tau_{crss} = \sigma_y \cos\Phi\cos\lambda = 13\text{MPa}\cdot\cos\left(45^\circ\right)\cos\left(54.7^\circ\right) = 5.31\text{MPa}$$