Definition of shear stress

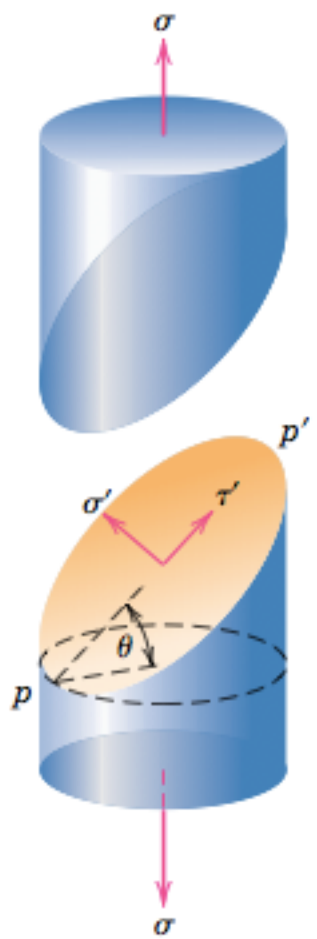

Figure 6.4
Schematic representation showing normal (σ') and shear (τ') stresses that act on a plane oriented at an angle θ relative to the plane taken perpendicular to the direction along which a pure tensile stress (σ) is applied.

$$\sigma' = \sigma \cos^2\theta = \sigma\left(\frac{1 + \cos 2\theta}{2}\right)$$

$$\tau' = \sigma \sin\theta \cos\theta = \sigma\left(\frac{\sin 2\theta}{2}\right)$$

7.5 SLIP IN SINGLE CRYSTALS

A further explanation of slip is simplified by treating the process in single crystals, then making the appropriate extension to polycrystalline materials. As mentioned previously, edge, screw, and mixed dislocations move in response to shear stresses applied along a slip plane and in a slip direction. As noted in Section 6.2, even though an applied stress may be pure tensile (or compressive), shear components exist at all but parallel or perpendicular alignments to the stress direction (Equation 6.4b). These are termed **resolved shear stresses,** and their magnitudes depend not only on the applied stress, but also on the orientation of both the slip plane and direction within that plane. Let ϕ represent the angle between the normal to the slip plane and the applied stress direction, and let λ be the angle between the slip and stress directions, as indicated in Figure 7.7; it can then be shown that for the resolved shear stress τ_R

resolved shear stress

Resolved shear stress—dependence on applied stress and orientation of stress direction relative to slip plane normal and slip direction

$$\tau_R = \sigma \cos\phi \cos\lambda \tag{7.2}$$

where σ is the applied stress. In general, $\phi + \lambda \neq 90°$ because it need not be the case that the tensile axis, the slip plane normal, and the slip direction all lie in the same plane.

A metal single crystal has a number of different slip systems that are capable of operating. The resolved shear stress normally differs for each one because the orientation of

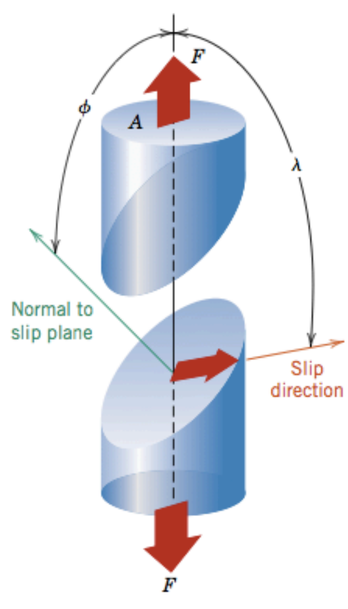

Figure 7.7 Geometric relationships between the tensile axis, slip plane, and slip direction used in calculating the resolved shear stress for a single crystal.