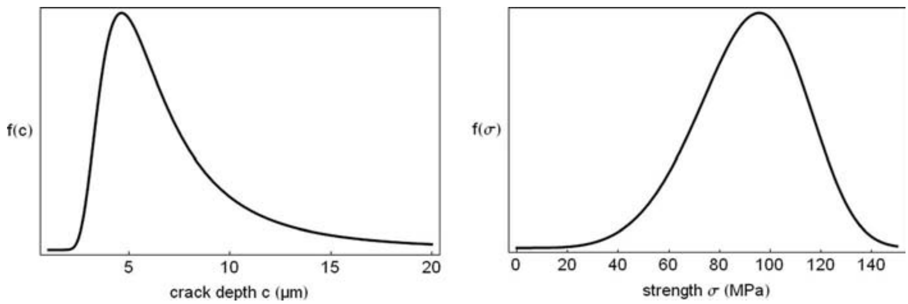

FIGURE 2 Example of the distribution of critical crack depth of a glass sample (*left*) and corresponding distribution of strength (*right*).

criterion is fulfilled (presence of significant flaws but no mechanical loads, or vice versa). Another result from equation (2) is that the scatter of fracture strength σ_{fract} (i.e., the distribution of the value of σ_{appl} at fracture measured from experimental testing) is given by the scatter of the critical crack depth c (Fig. 2):

$$\sigma_{\text{fract}} = f(c) = \frac{K_{\text{IC}}}{\sqrt{c}Y} \tag{3}$$

If K_{IC} is reached anywhere in the glass, fracturing will start from this spot immediately (i.e., a glass article will always break at its most severe defect). This behavior is comparable to a chain that will always fail at its weakest link. Strength testing of brittle materials such as glass involves the gathering of the strength data distribution to deduce the distribution of strength-determining surface defects (see sect. "Fracture Statistics"). Of course, the task of glass-container manufacturers is to consequently and continuously improve the quality of a product and to avoid any damage during production, packaging, and shipping of the product.

If the stress intensity factor K is less than K_{IC}, defects extend by subcritical crack growth. The velocity of this extension can range from 10^{-8} m/sec to more than 10^{3} m/sec and depends on the value of K and the chemical environment at the crack tip. As the defect depth grows continuously until K reaches the value of K_{IC}, subcritical crack growth is an important topic when considering the strength and reliability of glass products.

STRENGTH TESTING

Strength testing is necessary to determine the reliability of glass vials (i.e., determining its fracture probability for some certain mechanical load). An important requirement for the testing technique used is to simulate the mechanical load under usage conditions. Strength testing of glass is always destructive, thereby the weakest point that could have led to failure if the product was in service is detected for every single specimen. The location of failure (i.e., the origin of fracture) can be determined by means of fractography (see sect. "Fractography"). Knowing the weakest spot of a given geometry, quality improvement can be initiated, for example, by using finite element methods (FEM) as a tool for design optimization (see sect. "Finite Element