of the system. For surfactant systems, sufficient scientific investigations have been completed to begin to correlate emulsion (4,5), foam (6), and gel (7) stability with the equilibrium that exists between the thermodynamically stable micellar and liquid crystalline phases. Although the techniques for representing phase behavior described in this chapter are not limited to surfactant systems, they have been primarily applied to this area of study. Nontraditional formulations may generally be less dependent upon emulsifiers than current topical creams; however, binary and ternary phase representations are useful in characterizing any of a variety of systems. Most topical formulations are composed of materials that fall into one of three groupings: polar components, nonpolar components, and other components (e.g., amphiphilic, polymeric, therapeutic, biotechnology products). For any formulation whose components can be divided into two or three such groupings, binary or ternary plots of the phase behavior can be extremely useful in characterizing the physicochemical interactions between the components of the system. These physicochemical interactions between the individual components ultimately lead to the stability or lack of stability characteristic of pharmaceutical dispersions.

1. *Binary Systems*

Binary diagrams are typically plotted on Cartesian coordinate grids in which the composition is plotted along the abscissa and temperature is plotted along the ordinate. Phase boundaries are plotted on this grid to separate single-phase regions from multiple-phase regions. An idealized example of a two-component liquid system having an upper critical solution point is shown in Figure 1. The left vertical axis represents the phase behavior of pure A over the temperature range of interest, whereas the right vertical axis is for pure B. Both A and B are liquids for this temperature range at the given pressure. As expected, the solubility of B in A increases as the temperature is increased. This change in solubility is shown by the left phase boundary. Analogously, the changes in the solubility of A in B with increasing temperature is represented by the right phase boundary. The two-phase liquid–liquid region falls between these boundaries. The phase diagram provides considerable information about any sample that is mixed within the conditions represented by that diagram. First, for any binary mixture of components A and B, it can be discerned whether the sample will be one or two liquid phases. Second, if the sample is two phases, it can be discerned what the composition of each phase will be and how much each phase will weigh. For example, consider the point circled in Figure 1. Overall, this sample contains 40% A and 60% B. We can immediately see that this sample will separate into