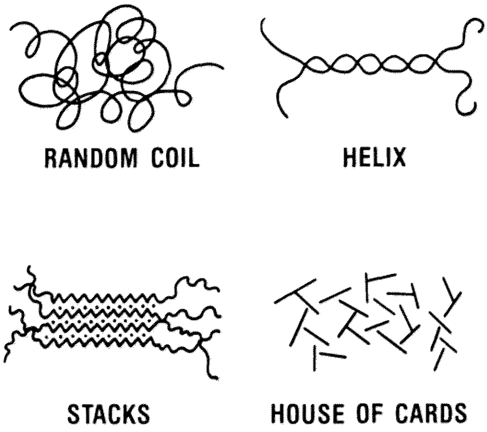

Figure 18.1 Gel structures.

This results in a reduction of the interparticle distances, which subsequently leads to chain entanglement and the development of cross-links. As the number of cross-links increases, the chains lock, solvent mobility is reduced, and a gel forms. Continued polymer addition strengthens the gel network and results in increased resiliency and viscoelasticity.

Although the gel network is basically formed through polymeric interactions, the nature of the polymer—solvent affinity actually determines the integrity of the gel. Classical gel theory distinguishes between three categories of solvents: (1) free solvent that is very mobile; (2) solvent bound as a solvation layer, usually through hydrogen bonding; and (3) solvent entrapped within the network structure. The ratios of the three solvent types in a given gel are dependent on the polymer concentration and the solvent affinity for the polymer. Solvent affinity governs extension of the random coil. The greater the solvent affinity, the more the coil expands and entangles with adjacent coils to form cross-links. In a good solvent, the polymer chains are interpenetrated by solvent molecules, and the solvation layer is enhanced. This facilitates random coil expansion and network formation. In a poor solvent, the polymer chains contract to minimize solvent contact, thereby reducing the effective number of cross-links and weakening the gel network structure.

II. FORMULATION

Gelation theory can be readily applied when formulating gel products. However, before discussing this topic, presentation of some desira-