metal-ion coordinated water. There are three classes that are discernible by the commonly available analytical techniques.

1. Class I includes isolated lattice sites and represents the structures with water molecules that are isolated and kept from contacting other water molecules directly in the lattice structure. Therefore, water molecules exposed to the surface of crystals may be easily lost. However, the creation of holes that were occupied by the water molecules on the surface of the crystals does not provide access for water molecules inside the crystal lattice. The thermogravimetric analysis (TGA) and differential scanning calorimetry (DSC) for the hydrates in this class show sharp endotherms. Cephradine dihydrate is an example of this class of hydrates.
2. Class II includes hydrates that have water molecules in channels. The water molecules in this class lie continuously next to the other water molecules, forming channels through the crystal. The TGA and DSC data show interesting characteristics of channel hydrate dehydration. Early-onset temperature of dehydration is expected, and broad dehydration is also characteristic of the channel hydrates. This is because the dehydration begins from the ends of channels that are open to the surface of crystals. Subsequently, dehydration keeps happening until all the water molecules are removed through the channels. Ampicillin trihydrate belongs to this class. Some hydrates have water molecules in two-dimensional (2D) space, and they are called planar hydrates.
3. Class III includes ion-associated hydrates. Hydrates contain metal-ion coordinated water and the interaction between the metal ions and water molecules is the major force in the structure of crystalline hydrates. The metal–water interactions may be quite strong relative to the other nonbonded interactions, and therefore, dehydration occurs at very high temperatures. In TGA and DSC thermograms, very sharp peaks corresponding to dehydration of water bonded with metal ions are expected at high temperatures.

Hydrates can also exist in various polymorphs, such as in the case of amiloride hydrochloride. A myriad of methods is available to study hydrates and their polymorphs, including DTA, DSC, XRPD, and moisture-uptake studies.

6.6 Amorphous Forms

Solid powders, wherein no particular order of molecules is technically noncrystalline, are called amorphous forms. The amorphous forms are formed by vapor condensation, supercooling of a melt, precipitation from solution, and milling and compaction of crystals. These are more like liquids, where the molecular interaction has weakened; in most instances, there would be some crystalline forms among the amorphous forms as well. This two-state model is described in the U.S. Pharmacopeia (USP). The amorphous forms are thermodynamically unstable, as they have high energy (that went into breaking intermolecular bonds). As a result, they might turn into a