point of the product. Melt crystallization, growing crystals from melt, is often applied to systems with high percentage of target product and operated at temperature close to the melting temperature of the components. Melt crystallization is driven by supercooling (temperature is lower than the equilibrium one). It is suggested by Ulrich *et al.* that "solution" could be used for a process where mass transfer effects dominate, while "melt" could be used for a process where heat transfer effects dominate. Besides, the growth rate of crystals for melt crystallization could be 3 orders higher than that of solution crystallization while still producing highly pure products.[2]

Compared to solution crystallization which could be used for modifying crystal size distribution and crystal morphology and help to optimize the manufacturing downstream processes, melt crystallization is generally used for purification, separation and concentration, instead of changing particle properties, and in most circumstances, purified product is obtained in liquid form.[5–8]

11.1.2 Features of Melt Crystallization

Melt crystallization has advantages and features that make it a potential and competitive separation method, compared to distillation and solution crystallization.[1,2,9]

Firstly, phase change happens between liquid and solid state in melt crystallization, which means the energy consumption is much smaller (usually one third to one seventh) than that for liquid–vapor phase change in distillation or evaporation crystallization processes. Meanwhile, compared to vapor, liquid occupies much less space for the same amount of substance. Therefore, the equipment volume for melt crystallization could be smaller and need less construction work, meaning less capital cost and less safety issues concerning pressure and leakage, and so on. Besides, about 60% of organics have melting points between 0 and 210 °C, which falls in the low-level energy range and could be operated using waste heat from other processes to further save energy cost. And heat sensitive substances, such as pharmaceuticals, food and vitamins, could be protected from decomposition or deterioration due to the low process temperatures.

Secondly, solvents are no more a problem in melt crystallization processes. In addition to the problems of solvent residue, solvent toxicity, as well as solvent consumption and recovery, the absence of solvent also means a smaller crystallizer. More importantly, melt mixtures normally have a relatively higher concentration of the product component, which will give rise to a higher purification effect and larger production capacity.

Furthermore, in these days, isomer separation remains a difficult challenge for distillation which will need many theoretical plates and high reflux ratio as a result of similar boiling points. As a result, if distillation is applied