Investigating the Kinetics of Moisture-Induced Crystallization of Amorphous Lactose

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Many low molecular weight amorphous materials will revert to their thermodynamically stable, crystalline form. This timescale of this transition is dependent on both temperature and humidity (or solvent partial pressure). Therefore, understanding the kinetics of this transition over a wide range of temperatures and humidity values is important for the processing and storage of materials containing amorphous phases.

Dynamic Vapor Sorption (DVS) is a well-established method for the determination of vapor sorption isotherms. It is based on a highly sensitive gravimetric system, which measures vapor adsorption and desorption. In the current study water sorption experiments were performed over a range of humidity and temperature conditions to investigate the crystallization kinetics of a spray-dried, amorphous lactose sample.

At 25 °C the onset time to crystallization for spray-dried lactose was measured over the 48 to 60% relative humidity range. The results indicated an exponential relationship between time to crystallization and humidity. Above 53% RH, crystalline lactose formation occurred in one step, while a two-step process was observed at 51% RH and below. For the one step process, crystalline lactose formation showed a sigmoidal relationship with time, suggesting Avrami [1] type growth kinetics.

i.) The crystallization kinetics were studied for a partially amorphous lactose sample.

ii.) The crystallization process had an exponential dependence on humidity.

iii.) Crystal growth at higher humidity values followed Avrami type kinetics.

References

[1] M.J. Avrami, Journal of Chemical Physics, 7 (1939) 1103.