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Physical stability and drug crystallization kinetics in amorphous solid dispersions

High-impact pharmaceutical drugs are constantly identified by (bio)medical research, with a high potential for the treatment of severe civilization diseases. However, such drugs often exhibit a very low solubility in water (and thus in bio-relevant media). As they tend to crystallize during storage or after administration, they cannot be used for the development of the future-generation pharmaceuticals. Therefore, about 80% of the promising drugs currently under development never make it into a medicine. Several approaches exist to increase the bioavailability of drugs. Most of them aim at formulating the drug in a less-stable but better-soluble modification which is intended to be stabilized with the help of excipients, e.g. polymers. However, finding the right excipient for a given drug is quite difficult and today usually established by a "trial-and-error" approach assisted by expensive high-throughput screening techniques. This results in tremendous costs for the development of advanced formulations and – when no appropriate formulation is found - even prevents a huge number of very promising drugs from being applied in a medicine at all. As pharmaceutical formulations usually have to be stored between manufacturing and use, it has moreover to be guaranteed, that their properties do not change during this period. This is best ensured when they are thermodynamically stable, i.e. at drug concentrations being lower than the drug solubility in the formulation. The latter is to a great extend influenced by the kind of drug and excipients, by temperature, and by relative humidity. It will be shown that the influence of humidity on the drug solubility in ASDs as well as on their kinetic stability can be predicted using thermodynamic models (1-3, 5). This provides the information whether an ASD will crystallize (destabilize) at humid conditions or not. However, the investigation of crystallization kinetics is usually performed by time-consuming long-term experiments with recurring investigations of crystallinity, e.g. by X-ray diffraction. In this work it will therefore also be demonstrated that the kinetics of drug crystallization in ASDs can be determined only based on simple water-sorption measurements combined with a state-of-the-art thermodynamic modeling of the drug solubility in polymers at humid conditions. The latter allows accounting for the mutual influence of water sorption and drug crystallization in the ASD and thus for simultaneously predicting the amount of absorbed water and crystallized drug. Knowing the experimental water sorption as function of time thus directly provides the ASD crystallinity without the need of additional X-ray measurements.

Biography

Gabriele Sadowski is Full Professor for Thermodynamics at TU Dortmund University. She is member of the Academy of Science and Arts North Rhine-Westphalia and of the German Academy of Engineering Sciences. She is the Chair of the German working party Thermodynamics and the German Representative in the European working party Thermodynamics and Transport Properties. She is author of about 200 scientific publications in high-reputation journals in the field of chemical, biochemical and pharmaceutical engineering. The main focus of her research is studying thermodynamic properties of complex systems with particular emphasis but not restricted to those containing biological and pharmaceutical molecules. To model the thermodynamic stability of those systems, her group developed the currently worldwide most-used thermodynamic model PC-SAFT which was published in 2001. She received numerous awards for her work, the most-prestigious one being the Gottfried Wilhelm Leibniz Award of the German Science Foundation in 2011.

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