Determination of glass transition temperature of polymers and the effect of plasticization

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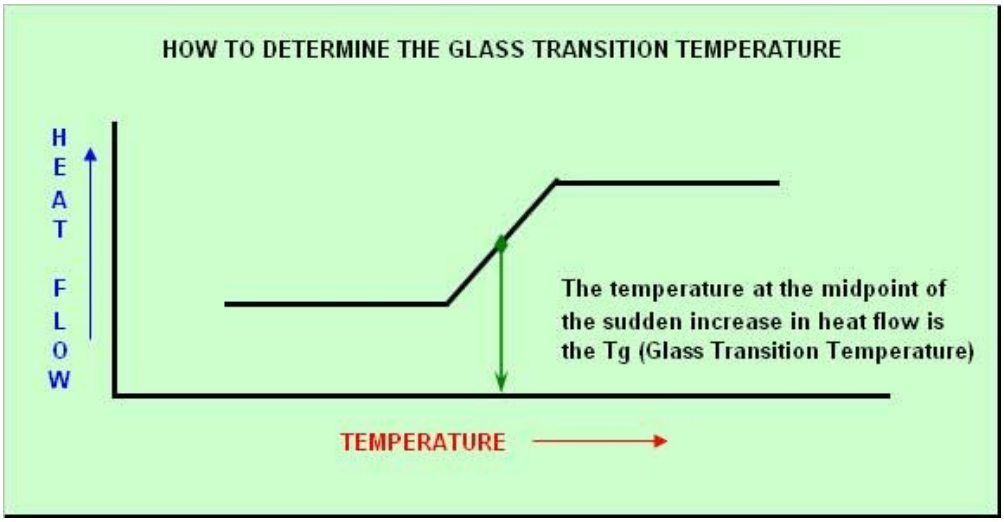
Theory

An important characteristic of amorphous polymers is the glass transition temperature (Tg). The glass transition is the gradual and reversible transition in amorphous materials (or in amorphous regions within semicrystalline materials) from a hard and relatively brittle "glassy" state into a viscous or rubbery state as the temperature is increased. The glass-transition temperature Tg of a material characterizes the range of temperatures over which this glass transition occurs. It is always lower than the melting temperature, Tm, of the crystalline state of the material, if one exists. Because the T_g is very sensitive to chemical and physical structure, it can be used to characterize materials. The T_g is the value in the middle of glass transition, the inflection point of the curve (Fig. 1). T_g is read on the second heating curve. The heating rate is important and should be 10 K/min when determining the T_g.

Figure 1.



Plasticization of the polymer reduces the T_g, viscosity, improves processability, increases the flexibility and diffusivity of the polymer, which affects the application of the preparation and the course of drug release, ie the resulting therapeutic effect of the preparation. Plasticized polymers are used in the formulation of coated tablets, thin films, matrix systems, medicated patches, implants *in situ* etc.

In pharmaceutical technology, diesters derived from either dicarboxylic acids (eg sebacic acid, azeolic acid) or from ethylene glycol or propylene glycol, triesters derived from phosphoric acid, citric acid (tributyl citrate, triethyl citrate) or glycerol (triacetin, tributyrin) are used as plasticizers. Structural water in the swollen polymer also has the function of a plasticizer. The choice of an optimal type and concentration of plasticizer ensures the desired course and time of th epolymer carrier degradation and the release of the incorporated drug.

Materials and instrument

Polymers: poly(D,L-laktid-*co*-glycolid) PLGA

Plasticizers: triethylcitrate (TEC); ethylpyruvate (EP), methylsalicylate (MS); triacetin (TA), tributyrin (T)

Aids: aluminum crucible for DSC

Instruments: DSC 200 *F3* Maia®

analytical balance d = 0,0001 mg

Method

1. Prepare samples for DSC measurements:
   - On an analytical balance, weigh an aluminum crucible with a lid and record the weight.
   - Weigh about 10 mg of test material into the crucible and record the weight.
   - Calculate the weight of the test material.
2. Thermal analysis on DSC:
   - Place the measured and reference sample (empty cup) in the instrument.
   - In the instrument SW, select a measurement template with a temperature mode suitable for the material being tested.
   - Enter the required parameters and start the measurement.
3. Use SW Protheus Analysis to evaluate the T_g of the tested material.
4. Record the T_g value and export the thermogram.

Conclusion

Explain the measured results, the effect of polymer, type and concentration of plasticizer on the glass transition temperature.

DSC measurement protocol

Student's name:

Instrument:

Sample:

weight of an aluminum crucible with a lid	
weight of an aluminum crucible with a lid and sample	
weight of the sample	

Temperature mode:

DSC scan: