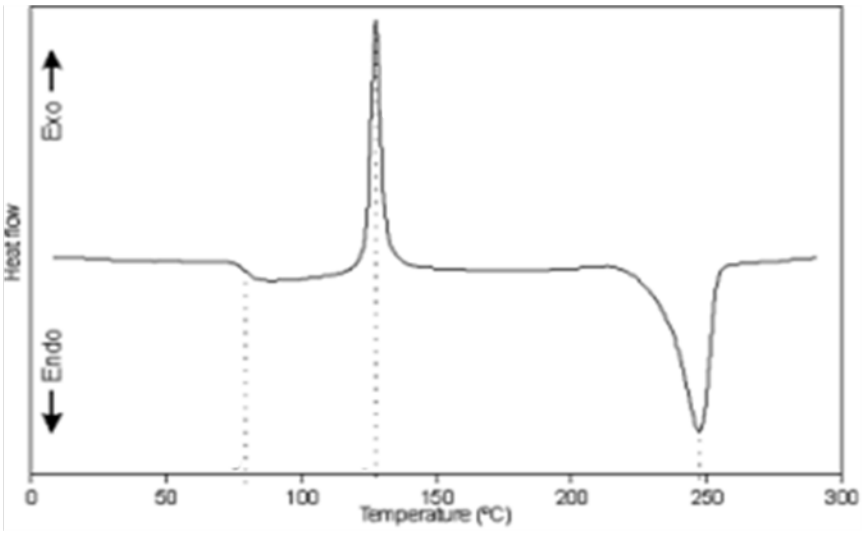
Exercises 4: Amorphous State and Glass Transition

4.1. A new polymer is reported to soften at 60°C. Describe a very simple experiment to determine whether this softening is a glass transition or a melting point.

4.2. Explain the following
(a) by dipping into liquid nitrogen, an adhesive tape loses its stickiness.
(b) A hollow rubber ball when cooled in liquid nitrogen and thrown hard against the wall breaks into pieces.

4.3: A DSC thermogram of a semicrystalline poly(ethylene terephtalate) was recorded at a heating rate of 1°C/min.

a.) Identify the glass transition temperature, the crystallization temperature, and the melting temperature in the thermogram below.



b.) What changes in the thermogram would you expect
- if the sample was cooled down rapidly ?

c.) - if the heating rate was changed to 10°C/min.

4.4: What is the effect on T_g if we increase the rate of sampling by a factor of 10?

4.5: Suppose a polymer has a T_g = 0°C. At 40°C, it has a melt viscosity of 2.5 x 10^5 poises (P) [= 2.5 x 10^4 Pa s]. What will its viscosity be at 50°C?

4.6: Di-n-ethylhexyl phthalate (DEHP) and related compounds are commonly used to plasticize poly(vinyl chloride) (PVC) to produce pliable material generically referred to as "vinyl". A good plasticizer is miscible with the polymer in question, does not crystallize itself, and has a very low vapor pressure. What fraction of DEHP should be added to PVC to bring T_g down below room temperature, say 293K, given that T_g for DEHP is about -86°C and for PVC 90°C respectively?

4.7: Styrene (T_g = 95ºC at 1ºC.min^{-1}) is copolymerized with an equimolar amount of propylene (T_g = -10ºC at 1ºC.min^{-1}) to form a statistical copolymer (both monomers were fully incorporated). What is the T_g of this copolymer? Assume that the thermal expansion coefficients and densities of both polymers are equivalent.