Exp. No. (3)

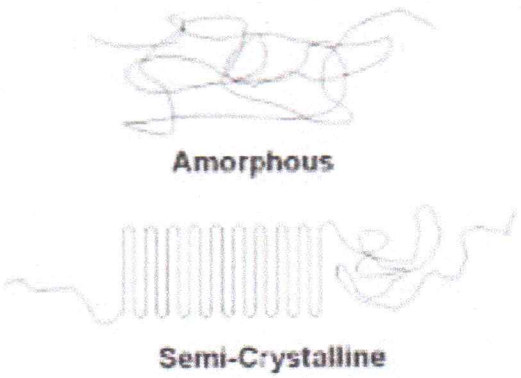
Determination the Degree of Crystallinity

Introduction

Crystallization of polymers have a significant effects on optical, mechanical, thermal and chemical properties of polymers.

The degree of crystallinity is estimated by different analytical methods and it typically ranges between 10 and 80%, thus crystallized polymer are often called semicrystalline).

The properties of semicrystalline polymers are determined not only by the degree of crystallinity, but also by the size and orientation of molecular chain.



The arrangement of molecular chains in amorphous and semicrystalline polymers

Most methods of evaluating the degree of crystallinity assume a mixture of perfect crystalline and totally disordered areas; the transition

areas are expected to amount to several percent. These methods include *density* measurement, *differential scanning calorimetry* (DSC), *X-ray diffraction* (XRD), *infrared spectroscopy* and *nuclear magnetic resonance* (NMR). The measured value depends on the method used, which is therefore quoted together with the degree of crystallinity.

Apparatus

1. Volumetric flask (5ml).
2. Glass rod.
3. Graduated cylinder.

Reagent and materials

Many samples of crystalline and amorphous polymers such as PE, PS, PP, PET and PVA.

Procedure

1. Put 5ml of distill water in cylinder 10ml capacity.
2. Put small piece of unknown polymer in the cylinder.
3. Notice the piece of polymer floated on the water surface or sink:

If

Sink	Float
Density of polymer is higher than density of water	Density of polymer is less than density of water
1. Add salt solution (NaCl or $Na_2S_2O_3$) with stirring.	1. Add ethanol or methanol drop by drop with stirring
2. When the piece of polymer raise in the solution and settled in the middle, it means density of polymer = solution density	2. When the piece of polymer move inside solution and settled in the middle it means Density of polymer = solution density

4. The quantity of solution is weighted with volumetric flask (W_2).
5. Calculate the density of solution which equal the density of polymer as

$$\text{Density} = \frac{W_2 - W_1}{V}$$

Where W_1 = weight of volumetric flask and V = volume of volumetric flask.

6. Determined the degree of crystallinity of polymer by

$$\% \text{ Crystallinity} = \frac{P - P_{am}}{P_{cry} - P_{am}}$$

Where P = density of polymer sample, P_{am} = density of amorphous polymer and P_{cry} = density of crystalline polymer.

7. Discussion of the results.

Table 2: Densities of crystalline and amorphous polymers

Polymer	**CryslallineP_{cry}**	**Amorphous P_{am}**	**P_{cry} - P_{am}**
PE	1.00	0.852	0.148
PP	0.937	0.854	0.083
PS	1.11	1.054	0.057
PET	1.455	1.335	0.120
P.V.al	1.345	1.269	0.076