

Quiz 8 Properties of Materials CME 300
November 21, 2011

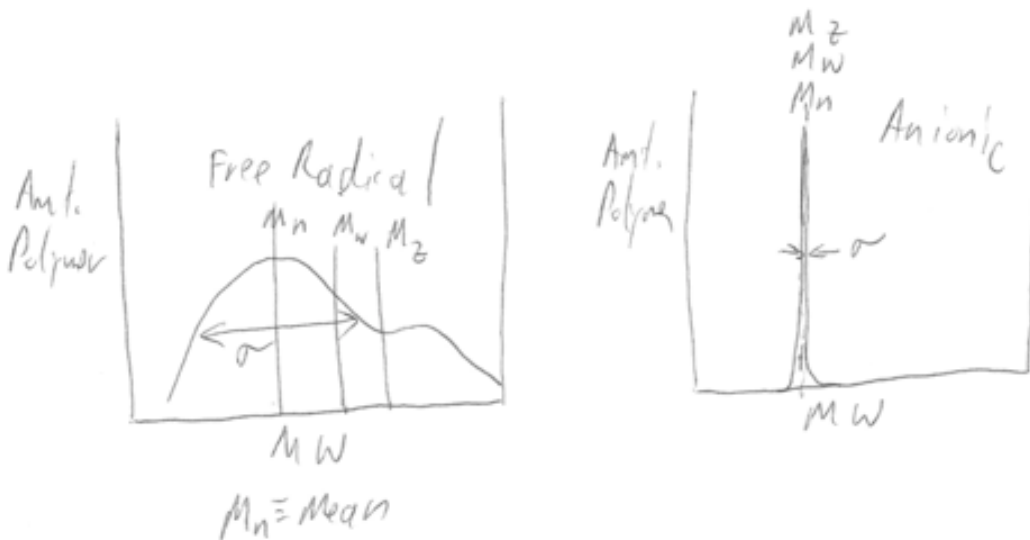
- 1) Sketch a plot of amount of polymer versus molecular weight for
 - a) a free radical LDPE polymer with $PDI = 16$ and
 - b) for an anionic polyethylene with $PDI = 1.01$.On these plots show the approximate location for
 - c) M_n ,
 - d) M_w ,
 - e) M_z ,
 - f) the mean value of molecular weight and
 - g) draw a double ended arrow indicating approximately the standard deviation.

- 2) You are working on a coop job for Celanese in the production of UHMWPE and PP and you have two samples that you would like to know the tacticity for:
Sample 1: UHMWPE, M_w 2,000 kDa, $PDI = 1.1$
Sample 2: Polypropylene, M_w 120 kDa, $PDI = 2.0$
 - a) A technician returns with a value of 35% isotactic, 40% syndiotactic and 25% heterotactic for Sample 1. Comment on this result.
 - b) The same technician (who you now begin to question the capabilities of) says that the polypropylene sample is atactic since it shows 33% isotactic, 33% heterotactic and 33% syndiotactic triads. Comment on this result.
 - c) What is the diad tacticity for the polypropylene polymer? If he had reported the diad tacticity rather than the triad tacticity would this have changed your opinion of the technician? Explain.
 - d) Why didn't the technician report diad tacticity values to you?
 - e) If you want to predict crystallinity what tacticity values do you need?

- 3) When a polymer is synthesized the result is a powder, often called a reactor powder.
 - a) What is the first processing step used to get this polymer into a state that can be shipped? (i.e. generally in what state are commercial polymers sold?)
Sketch the following polymer processing equipment and highlight a common and necessary processing component also used in a) above.
 - b) Film casting.
 - c) Film blowing.
 - d) Injection molding.
 - e) Wire coating.

ANSWERS: Quiz 8 Properties of Materials CME 300
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- 1) Sketch a plot of amount of polymer versus molecular weight for
- a free radical LDPE polymer with $PDI = 16$ and
 - for an anionic polyethylene with $PDI = 1.01$.
- On these plots show the approximate location for
- M_n ,
 - M_w ,
 - M_z ,
 - the mean value of molecular weight and
 - draw an arrow indicating the standard deviation.



- 2) You are working on a coop job for Celanese in the production of UHMWPE and PP and you have two samples that you would like to know the tacticity for:

Sample 1: UHMWPE, M_w 2,000 kDa, $PDI = 1.1$

Sample 2: Polypropylene, M_w 120 kDa, $PDI = 2.0$

- a) A technician returns with a value of 35% isotactic, 40% syndiotactic and 25% heterotactic for Sample 1. Comment on this result.

Polyethylene does not have tacticity.

- b) The same technician (who you now begin to question the capabilities of) says that the polypropylene sample is atactic since it shows 33% isotactic, 33% heterotactic and 33% syndiotactic triads. Comment on this result.

Atactic triads are 25% iso, 25% syndio and 50% hetero. This polymer is a mixture of predominantly iso and syndiotactic. It is not atactic in the sense of random tacticity. It probably doesn't crystallize.

c) *What is the diad tacticity for the polypropylene polymer? If he had reported the diad tacticity rather than the triad tacticity would this have changed your opinion of the technician? Explain.*

50% meso and 50% racemic. The polymer appears to be atactic from the diad tacticity but the triads are not arranged randomly.

d) *Why didn't the technician report diad tacticity values to you?*

The technician used NMR to measure tacticity. NMR can only measure triads or higher odd moment distributions of tacticity since it receives a symmetric signal from a chiral atom.

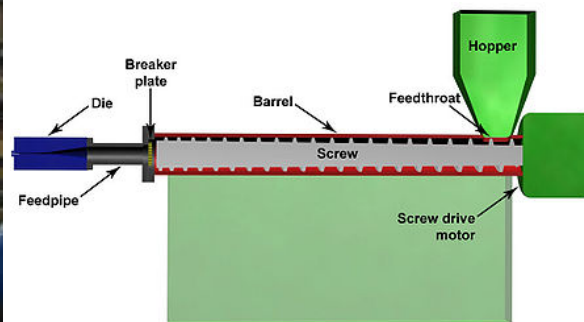
e) *If you want to predict crystallinity what tacticity values do you need?*

Polymers crystallize in lamellar sheets of about 20 to 100 monomer thickness. So you would, ideally, want to know the odds of a sequence of 20 to 100 monomers. This is not possible by NMR. It is most useful to have as high an order of tacticity as possible, i.e. pentads, heptads or higher in order to predict crystallinity.

3) *When a polymer is synthesized the result is a powder, often called a reactor powder.*

a) *What is the first processing step used to get this polymer into a state that can be shipped? (i.e. generally in what state are commercial polymers sold?)*

The polymer is first fed into an extruder and pelletized.



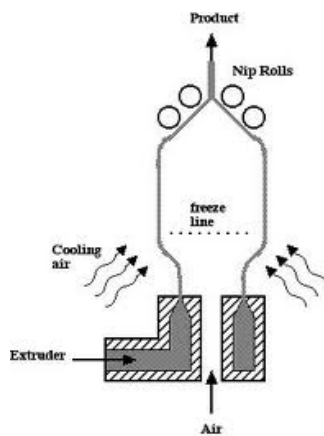
Sketch the following polymer processing equipment and highlight a common and necessary processing component also used in a) above.

The extruder is the common processing equipment in all of the examples.

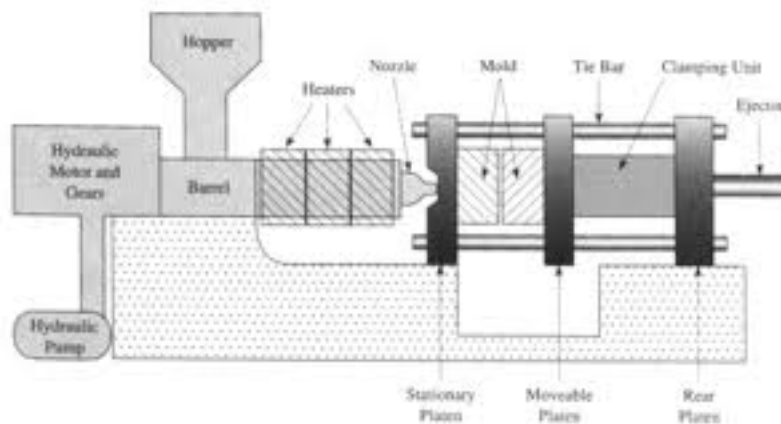
b) Film casting.



c) Film blowing.



d) Injection molding.



e) Wire coating.

