Fiber Composite Theory for Modeling Oriented Films

Solutions

1.) a.) the fiber structures appear to have a large aspect ratio (via microscopy techniques)

b.) entanglements between fibers prevent slippage between the fiber and matrix, resulting in an efficient transfer of stress from the matrix to the fiber

c.) the system is well behaved, meaning that the dynamics of fiber formation is uniform throughout the film.

2.) a.) low molecular weight polymers do not produce crystalline regions that when oriented produce fibers with large aspect ratios

b.) incompatability between the matrix and the fiber results in slippage between the phases, resulting in an inefficient transfer of stress to the fiber

c.) a system (say a blend) containing two different polymers that form different types of fibers.

3.) Slippage between the fiber and matrix could result from poor adhesion between the phases. To account for this, a factor relating the efficiency of stress transfer between the matrix and fiber can be included. The modified infinitely long fiber composite theory model would then be:

$$E = \Omega E_f \phi_f + E_m \phi_m$$

where Ω is an efficiency factor that tends towards $\Omega = 1$ when there is perfect adhesion between the matrix and the fiber.

4.) Increasing the drawing temperature increases the maximum attainable draw ratio

5.) Changing the draw ratio results in an exponential increase in the calculated volume fraction of fibers present in the oriented film. This results in a linear increase in machine direction modulus and tensile strength with respect to ϕ_f and a linear increase in transverse direction modulus with respect to $1/\phi_f$. The machine direction breaks strain quickly goes to a very low value at moderate ϕ_f, meaning there is minimal yield in the film. The yield strain and break strain begin to converge and the stress/strain curve becomes more "Hookean"