Plastic yielding formation and plastic deformation

Young Mok Lee and Sung Soon Im
Dept. of Textile Engineering, College of Engineering, Hanyang Univ.

There are two general types of model which attempt to explain the structural transformation of semicrystalline polymers.

Firstly, the currently accepted mechanism is due to Peterlin. Under assuming that in semicrystalline polymer, the neck is to a large degree caused by the special geometry of crystal lamellae orientation and the strong dependence of plastic deformation on angle between the chain axis and the applied stress, in the Peterlin model, plastic deformation is accomplished when folded chain blocks are titled, sheared, and eventually broken off the lamellae, and become incorporated into microfibril.

Also, Peterlin has proposed that the heat generated during the plastic deformation cannt be removed fast enough. This heat brings about a large amount of chain mobilization in blocks so that they rearrange with a new long period corresponding to the true temperature of drawing, which is related to the sum of the draw temperature and a temperature rise caused by extension energy.

Secondly, mechanical melting mechanism is proposed by the many other researchers.

Especially, Juska and Harrison has porposed that plastic yielding and plastic deformation is occurred through crazing by means of mechanical melting at the draw temperature caused by the maximum elastic strain energy at a given draw temperature.

Unlike Peterlin's model, they assume that the temperature rise of neck is the direct result of heat loss on recrystallization of an already transforming volume element. In this paper, we attempt to describe stretctural transformation process associated with the plastic yielding and plastic deformation of semicrystalline polymers by simply modifying the mechanical melting mechanism of Juska and Harrison about glassy polymer. Using the simply modifying mechanical melting mechanism, we calculate the critical uniaxial stress for plastic yielding by phase transition. Also, according to the difference of two assumptions, if Peterlin's model is true, the temperature rise of the neck region at the draw temperature should influence the heat of fusion of drawn semicrystalline polymer, and if mechanical melting mechanism is correct there should be little influence of the temperature rise in the neck on the heat of fusion. Therefore, we measure the heat of fusion of drawn PE at different drawn temperature and different draw rate.