

Shear rate effect on fiber attrition

The effect of shear rate on fiber attrition was investigated using a capillary rheometer equipped with a 1 mm orifice die. PPA-1950 was loaded into a barrel and held at 330C for at least 10 minutes to completely melt the pellets. The melt was subsequently extruded through the die at 330C continuously at various shear rates, ranging from 3000 to 10 s⁻¹ under air. The extrudates were collected for further fiber length analysis. Figure 1 describes the sample preparation steps for fiber analysis.

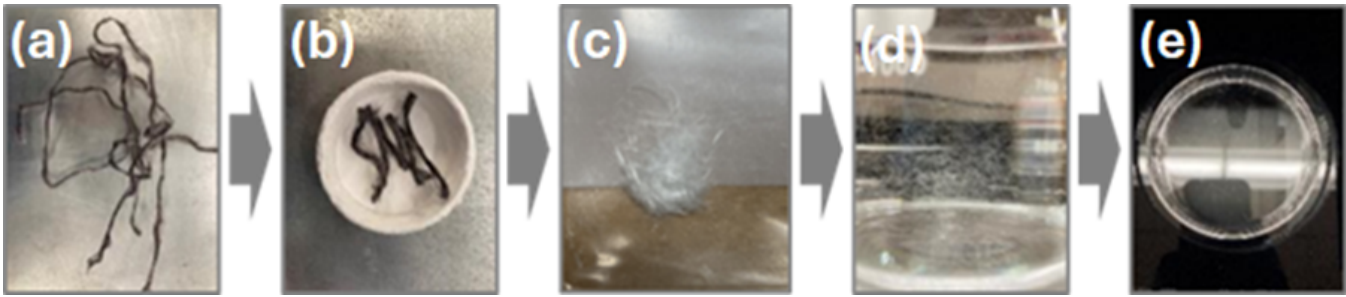


Figure 1. Fiber analysis steps: (a) extrudate, (b) sample cutting, (c) glass fiber after removal of the polymer matrix, (d) glass fiber dispersed in water, and (e) fiber/water solution in a Petri dish.

The extrudates were cut into ~1.5 inch pieces. The polymer matrix of the sample was removed by burning in an oven at 800C for 3 minutes. 0.1g of fibers was dispersed in 1L of deionized water with a few drops of surfactant to mitigate fiber aggregation. The fiber/water solution was stirred for at least 10 minutes to achieve uniform dispersion, then poured into a Petri dish for imaging using FASEP. More than four images were taken for each sample to obtain the average fiber length and distribution, which were automatically calculated by the FASEP software. In this project, weight-average fiber length (L_p) is used rather than number-average fiber length (L_n) because L_p provides a more representative statement on the weighting of the fiber length in LFT materials. Figure 2 shows (a) the fiber length distribution, (b) average fiber length (L_p), and (c) fraction of 9 mm fibers after extrusion using the capillary rheometer. As the shear rate increases from 10 to 3000 s⁻¹, the fiber length (L_p) exponentially decreases from 7000 to 4500 micron. Moreover, the volume fraction of 9 mm fibers, which are same length as the original fiber length in a pellet, also decreases exponentially.

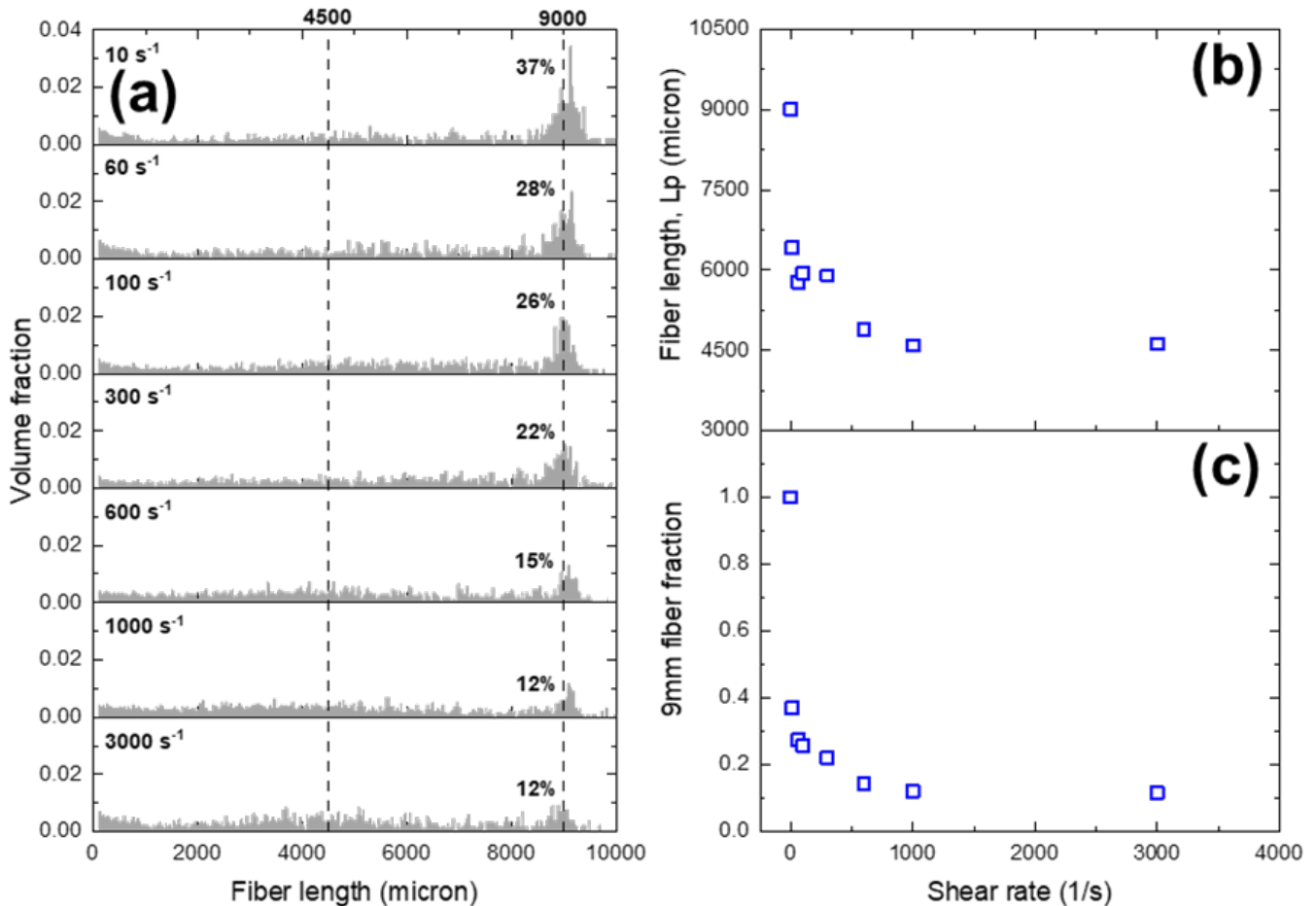


Figure 2. (a) Fiber length distribution, (b) average fiber length (L_p), and (c) fraction of 9 mm fibers as a function of shear rate, using a capillary rheometer equipped with a 1 mm die at 330C.