Effect of Contact Pressure on the Wear and Friction of PTFE-PEEK Composites

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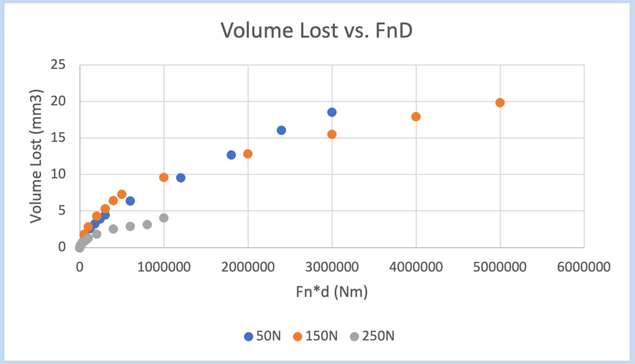
Introduction

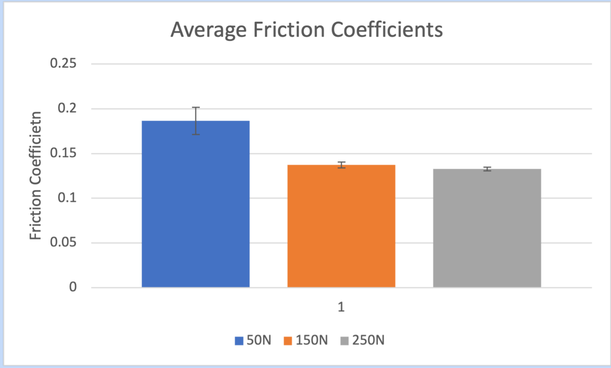
Polytetrafluoroethylene (PTFE) is a known homopolymer with remarkably low friction coefficients, good thermal stability, low surface energy, and hydrophobic properties, but is often passed over for usage due to its inherent high wear rate when unfilled (1-3). Wear rate is a descriptive statistic in tribology—the study of interacting surfaces in relative motion—that notes the amount of material removed per unit of time (4-5). However, experimentation by Pitenis et al. as well as others has shown that when the PTFE is filled by alpha-alumina nanocomposites or other polymer-based composites such as polyether ether ketones (PEEK), the wear rate decreases by several magnitudes (1-3). To find this data experimentally, the mixed polymer composites are run through tens of thousands of cycles on a tribometer, a machine that slides samples against a non-reactive counter-sample on a moving stage back and forth to measure statistics of friction and wear. The high throughput tribometer used in this lab was designed and engineered at Florida State in Dr. Krick's lab. This experiment sought out to understand the relationship between each PTFE filler composite and its ability to lower the wear rate of PTFE in vacuum, as well as determine which is the most practical.

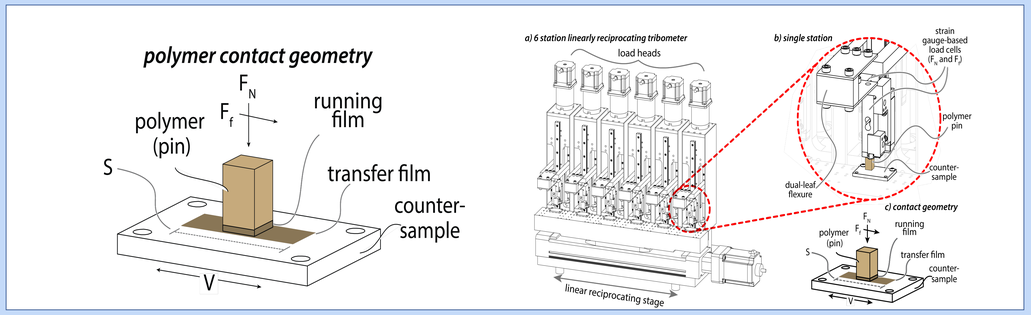
Methods

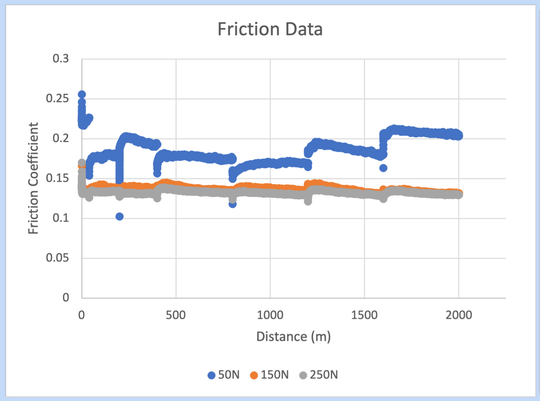
- First, the polymer was mixed, pressed, and machined. 24 grams of jet-milled, unfilled PTFE 7C was mixed in IPA using a sonification horn with 6 grams of 450 PEEK for a 20 wt.% PEEK polymer mixture.
- Next, the polymer was hydraulic pressed into a cylindrical form, then machined into 3 small, flat-edged pins that would be used as the samples.
- They were measured and massed for density calculations and then placed on the tribometer at loads of 50N, 150N, and 250N.
- Samples ran for increasing, back and forth cycles of 20mm at 50mm/s.
- After each run, samples were re-massed and placed back on tribometer for the next run.

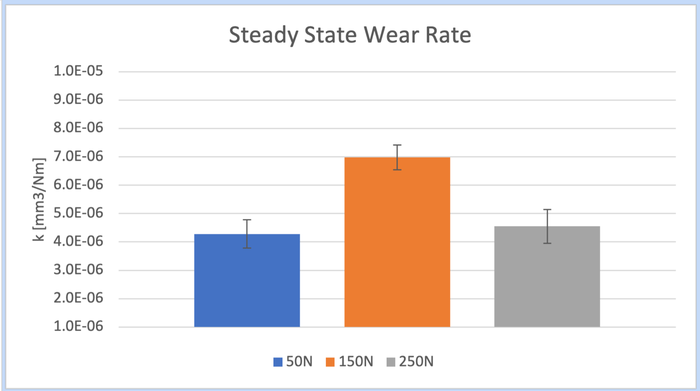
Results











Conclusions

Following an analysis of the results of the experiment, several inferences can be made about the performance of the polymer under varying loads. As expected, the volume lost increased as the load amount did, as there was more force being applied to drag greater amounts of material onto the counter-sample. There is also an observation to be made that Sample 1 reached steady state faster than the other samples. However, it must be acknowledged that an unexpected wear event took place where the transfer film was stripped and removed a heavy amount of volume again, essentially pulling the sample out of steady state and causing it to rebuild the transfer film again. This took place during the last experiment run and is depicted by the change in behavior on the graph. Following this research, there is definitely more to research and discover regarding the behavior of the polymer at different temperatures and at constant load, but varying wt. % of PEEK.

Acknowledgements

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