6. Recommendations
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1) Because the PET/HX1000 pregenerated microcomposites showed some success, additional research using HX1000 as the reinforcing phase would be useful. In particular, matrices such as polypropylene, polyamide 6, and polyamide 11 should be used because these have melting temperatures at or just above the glass transition temperature \( T_g \) of HX1000. By being able to process these materials at temperatures much closer to the glass transition temperature of HX1000, it should be possible to make pregenerated microcomposites with properties closer to theoretical expectations.

2) Another potential way of producing pregenerated microcomposites with properties closer to theoretical expectations is to use a TLCP with a higher glass transition temperature. Although HX1000 has the highest glass transition temperature of the DuPont TLCPs that have been used in making wholly thermoplastic composites, other TLCPs with higher glass transition temperatures have been produced [1]. A TLCP with a \( T_g \) of 200°C to 220°C which could be spun into strands has the potential to be used to make pregenerated microcomposites, especially if combined with matrices with low melting points which could be injection molded below the \( T_g \) of the TLCP.

3) The HX6000/HX8000 blend work showed that the melting endotherms shifted upward as the weight fraction of HX6000 was increased. This poses the possibility of doing a study examining how the melting endotherms affect the final properties of the pregenerated microcomposites. Namely, a series of polypropylene/TLC composite strands could be spun, with the TLCP consisting of neat HX8000, neat HX6000, and blends of HX6000/HX8000. These could then be injection molded at 180°C to 190°C and their mechanical properties measured. This would serve to help quantify the effect of the melting endotherms on the final pregenerated microcomposite properties.

4) The coinjection molding work (see Appendix A) demonstrated that the concept of coinjection molding pregenerated microcomposites could succeed. This area may be worth further investigation. In particular, low melting matrix polymers (such as polypropylene, nylon 11, nylon 6) combined with HX1000 may show particular promise because HX1000 has such a high glass transition temperature. In this research, work determining how to improve the interfacial adhesion between the skin and core would be useful too, because the experimental results with PET/HX1000 coinjection molding pregenerated microcomposites possessed lower tensile properties because of delamination at the interface.

5) Because ideally the pregenerated microcomposite melt should behave like a solid-filled melt, it would be informative to compare the rheology of pregenerated microcomposites to that of glass-fiber filled systems. Particularly interesting would be
to choose a matrix/TLCP blend which would allow a wide range of temperatures to be explored, so as the effect of melt temperature on the melt rheological behavior could be ascertained.

6) Because of the success in changing the cooling behavior of HX6000 of adding HX8000, other TLCP/TLCP blends should be studied. In particular, blends of HX6000/HX7000 and HX7000/HX8000 may show particular promise because HX7000 has a melting temperature of 354°C and is spinnable. Blending HX7000/HX8000 together may be a perfect method of varying the solidification temperature over a wide range while simultaneously retaining spinnability, further broadening the range of matrix/TLCP composites which could be made.

7) In spinning composite strands with the dual extruder system, the residence time in the mixing section of the dual extruders is around 2 to 4 minutes. This limits the possible matrix/TLCP combinations because the TLCP must remain deformable as it passes through the static mixer section. In particular, high melting TLCPs can not be combined with low melting matrix resins without either premature solidification of the TLCP or degradation of the matrix. Because of this problem, a study should be undertaken to determine if shorter residence times could allow more matrix/TLCP combinations to be spun. Rather than using static mixers, perhaps adding just a spin pack directly after the distribution tee may allow composite strands to be spun with high melting TLCPs. The spin pack may serve to split the TLCP streams while simultaneously reducing the residence time in the dual extruder, thereby yielding a final composite strand with small diameter fibrils. If this was successful, it would be possible to produce composite strands of materials such as PET/HX6000, which potentially would serve as better materials for the regenerated microcomposite processing scheme.

8) A more fundamental area which may be worth investigating is to determine how die design affects orientation in the composite strands. In particular, it has been observed that dies with larger exit diameters tend to produce strands with lower mechanical properties, even after drawing. By spinning composite strands using an amorphous polymer, such as polycarbonate, and a semicrystalline TLCP, such as Vectra B950, composite strands could be spun and the molecular orientation in the TLCP fibrils analyzed. From this information, it may be possible to ascertain if the extensional deformation of the melt as it exits the die is enough to highly orient the TLCP. Note that this experimental work also lends itself to numerical simulations of how the melt should deform as it reaches the die exit, so investigations comparing experimental results to numerical simulations could be made. Ultimately, this would be useful because it would serve to further optimize the spinning process, helping maximize the reinforcing potential of the TLCP phase in the composite strands.
6.2 Reference