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Technical Note

Micro-tube extrusion for biomedical applications using an Xplore MC 15 HT coupled with a micro-tube die

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Micro-tubes, having very thin walls such as smaller than 1 mm, are used in the biomedical field as drainage devices in the treatment of wounds, glaucoma, etc.   Drainage devices are used to remove puss, blood or other fluids from a wound or surgical site, helping to prevent infection and advance healing. In addition, like in glaucoma treatment, drainage devices can lower the intraocular pressure to prevent the progressive damage of the retinal ganglion cells.

One of the methods to produce thin-walled microtubes is the dip-coating of a mandrel using a polymer solution. However, using solvents and difficulty controlling the wall thickness are the drawbacks of this method. However, melt-extrusion of micro-tubes can be alternatively used to prepare sub-millimeter tubes using appropriate polymeric materials.
Recently, Xplore Instruments has developed a micro-tube extrusion die compatible with an MC 15 HT and an MC 40 to produce continuous tubes with a possible wall thickness of a few millimeters to a few hundred microns. The extrusion die can also be operated using pressurized lumen air to prevent the collapse of the tube walls before cooling.

One of the advantages of using a micro-compounder in combination with a micro-tube extrusion die is to formulize the ease of formalizing the compound to be extruded. Thanks to the smaller volume and high-shear intensity of the micro-compounders of Xplore, the preparation of a tailor-made polymer formulation is quick and cost-effective.

In this article, we aimed to show how the micro-extrusion parameters affect the size/shape of the micro-tube prepared using a biomedical-grade thermoplastic polyurethane. A picture of the micro-tube die is given in Figure 1.

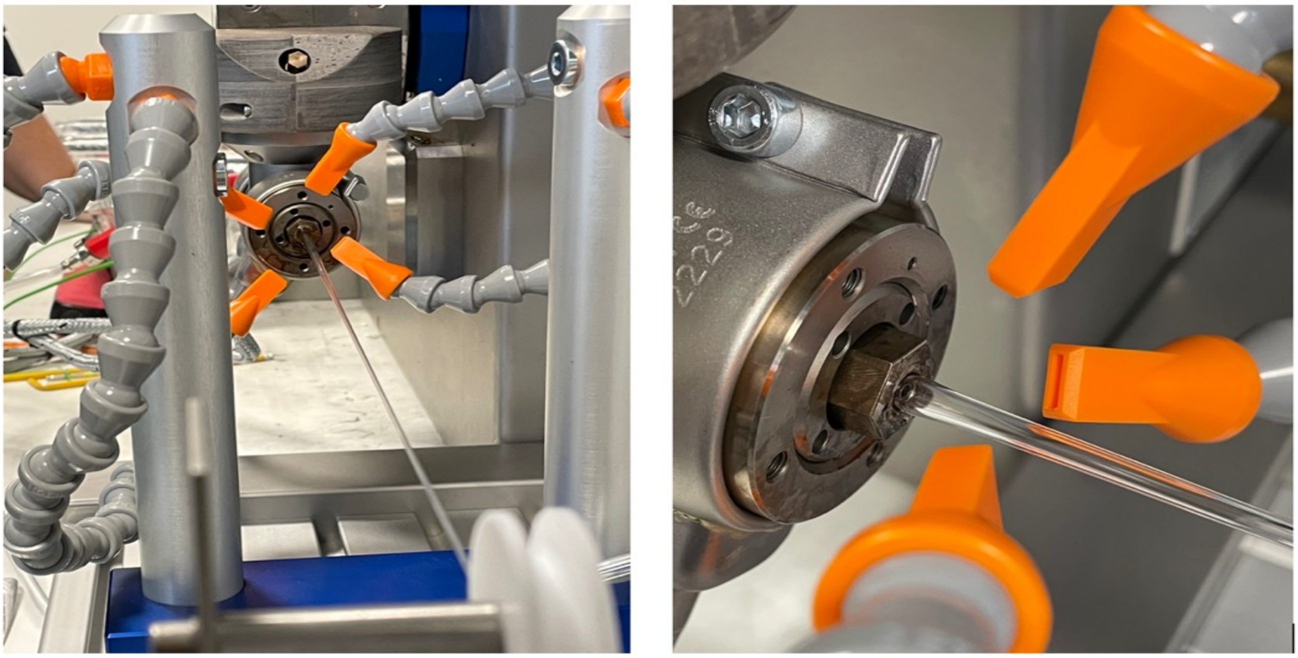

Figure 1. The micro-tube die attached to an MC 15 HT

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A 3 mm die with a 1.5 mm needle is used to make the pipes. The melt and die temperatures were set at 210°C, which Is approximately 20°C above the melting temperature of the polyurethane used.
The line speed was varied between 1 m/min to 20 m/min to observe the change in the micro-tube size and shape variations concerning take-up speed.
Note that the feed rate and the screw speed of the compounder were kept constant. As seen in Figure 2, the size of the tubes can be controlled by changing the take-up speed.
As expected, increasing the rate decreased the outer diameter and the wall thickness.
A minimum of 170 microns outer diameter and 45 microns wall thickness could be obtained successfully.
The coaxiality of the tube was good (Figure 3).

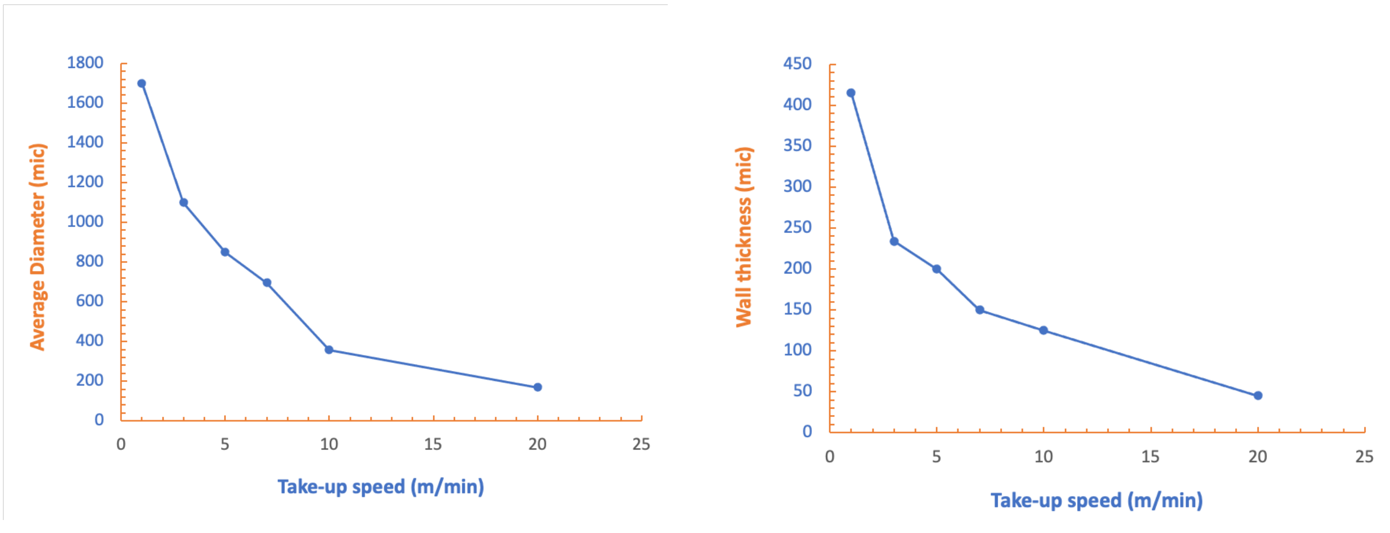

Figure 2. The change of outer diameter and the wall thickness of the micro-tubes in relation to the take-up speed

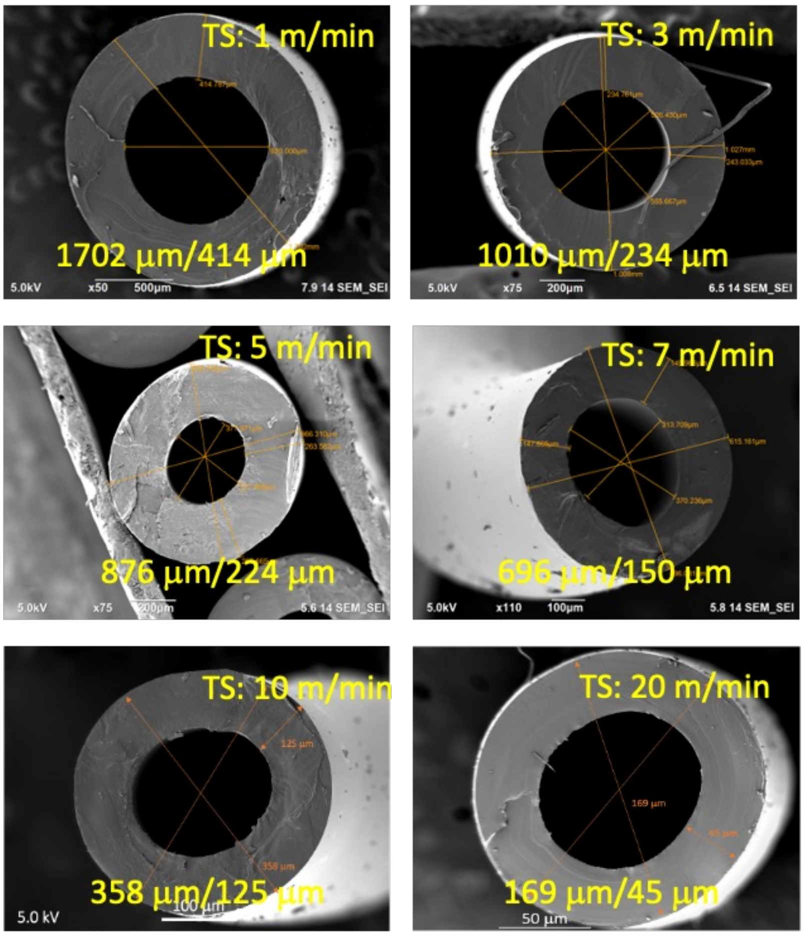

Figure 3. The representative micro-tube dimensions obtained with different take-up speeds

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