

TEXTURING ON FLEXIBLE TUBING

FIELD OF INVENTION

The present invention relates to the field of creating texture on the surface of the medical flexible tubing during the extrusion process.

BACKGROUND OF THE INVENTION

Flexible tubing with helically wound heated conductor or conductive wire is commonly used in medical applications such as respiratory equipment, anesthesia delivery hoses, CPAP (Continuous Positive Airway Pressure) machine, etc. where transparency and the ability to be heated using heating wires provide a solution to control not only the presence of moisture but also to suitably heat-up and adjust the air in the device to the desired temperature. For such flexible tubing that are manufactured using extrusion, the word “helix” refers to the electrically conductive wire itself that is encapsulated by a plastic material. Next the word “ribbon” refers to the plastic film for the flexible tubing, and shall be used throughout this writeup to mean as such.

For flexible tubing, the interior of the tubing has to be kept clean and smooth as much as possible in order to facilitate the air flow from one end to the other. Also, having the interior surface being smooth aids in lowering the air pressure needed to enable air flow from one end to the other. As for the exterior of the flexible tubing, it has to be kink-resistant and preferably clean and not permeable to moisture or air. Traditionally the helix of the tube is left as an extruded surface with no further treatment. This embodiment of the present invention aims to introduce a new method to give the helix a textured pattern. Texturing the exterior surface of the flexible tubing with patterns provide visual aesthetic appeal for the user. In addition, the visual aesthetic appearance

can also be enhanced if the flexible tubing is extruded using polymer or plastic resins with different colored additives. Moreover, texturing on the surfaces can have the added advantage of improving the hydrophobicity of the flexible tubing. By introducing textures of different patterns on the polymeric or plastic surfaces of the tubing, it generally increases the contact angle and hence improving the hydrophobicity of the polymeric flexible tubing. The effect of surface texture on hydrophobicity significantly varies with the texture geometry and dimension. Hydrophobic polymer surfaces can provide the self-cleaning capability as well as improvement in long-term mechanical behavior of the polymeric product, i.e., the flexible tubing as mentioned earlier. This improvement in long term mechanical performance can significantly increase the lifespan of the polymeric or plastic material used for the flexible tubing. Hence each designated shape, size and dimension of the texture pattern has its own unique function and role.

Flexible tubing with or without helically wound heated conductor or conductive wire can be manufactured using extrusion process whereby the helix and ribbon portion can be of different polymeric material. The polymeric material chosen will need to be biocompatible for use in the breathing machine to transport air from machine to the user. Texturing of a certain shape and pattern can be transferred to the helix portion via means of a special roller that has the textured surfaces created on it.

The present invention discloses a method that uses a roller that permits texturing on the outer surfaces of the extruded helix that is overlapping on the extruded flat plastic ribbon, whereby the helix is embedded with or without at least one or more electrically conductive wire. The roller's surface has textures of various different patterns (ranging from centimeter to millimeter or even micrometer) on the contact area, whereby such textured shapes with certain dimensions can be created via laser texturing or other

similar methods. The roller is placed next to the extrusion mandrel and is facing opposite the tool die where the helix is being extruded out such that the roller will transfer a texture to the surface of the extruded helix by virtue of pressure applied to the extrudate (helix). Concurrently this pressure action will also enable the extrudate (helix) to have better bonding over the electrically conductive wire. This texturing action will have to be quick and done before the entire polymeric extrudate is cured and cooled in a water bath.

For the present invention, it can have the following advantages:

1. Ability to extrude and form medical flexible tubing with textured helix of various different patterns.
2. Ability to extrude and form medical flexible tubing which has kink-resistant properties.
3. Ability to extrude and form medical flexible tubing that has aesthetic appeal with potentially different color and is functionable, example with hydrophobic properties.

BRIEF DESCRIPTION OF THE DRAWINGS

The drawings attached here are to aid comprehension of the description of the invention here. The drawings are not to scale and they are to be used for merely illustrating the principles and concepts of the invention only.

To aid in comprehension of the invention, the drawings are separated into the various Figures as described below:

Figure 1 illustrates an exploded view of the various key components and functions related to the embodiment of the present invention.

Figure 2 illustrates the perspective view of the mechanism in motion based on the embodiment of the present invention.

Reference numbers

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| 1 | Roller Die Jig Assembly |
| 2 | Roller |
| 3 | Lever Handle (for roller and is angle adjustable) |
| 4 | Lever Handle (for distance adjustment) |
| 5 | Jig Bar |
| 6 | Base Plate (to be mounted on the machine gear box) |
| 7 | Mandrel |
| 8 | Combined Tool Die |
| 9 | Extruder (Helix) |
| 10 | Extruder (Ribbon) |
| 11 | Ribbon |
| 12 | Helix |
| 13 | Electrically Conductive Wire |
| 14 | Flexible Tubing |
| 15 | Gear Box |

DETAILED DESCRIPTION OF PREFERRED EMBODIMENT OF THE PRESENT INVENTION

In the following description, details are provided to describe the embodiment of the application. It shall be apparent to the person skilled in the art, however, that the embodiments may be practiced without such details.

The present invention relates to the field of creating texture on the surface of the medical flexible tubing during the extrusion process, via the use of a roller's surface with textures of various different patterns.

Figure 1 illustrates an exploded view of the various key components and functions related to the embodiment of the present invention. **Figure 1** illustrates the roller die jig assembly **1** that can be attached to any typical extrusion machine that can extrude flexible tubing. For the purposes of illustrating the actual action of the embodiment of the present invention, we shall illustrate using only the key components from the extrusion machine (not the entire full extrusion machine layout) such as the mandrel **7** as well as the tool die (denoted as **8**) for the flexible tubing extrusion that has been mentioned in the prior art **PCT/SG2022/050368**. As illustrated in **Figure 1**, the entire roller die jig assembly **1** can be attached to any typical extrusion machine gear box **15** via the base plate **6** such that the roller **2** is positioned next to the mandrel **7**. The surface of the roller **2** has textures with various different patterns on the contact area, a lever handle **3** that is able to adjust the positioning of the roller **2** and a lever handle **4** that is able to adjust the left-right positioning of the roller **2** via the jig bar **5**. The textured surface on the roller **2** can be of various different patterns that can be created via laser texturing or other similar methods.

Figure 2 illustrates the assembly **1** being attached to the extrusion machine with mandrel **7**. During manufacturing of the flexible tubing, the plastic ribbon **11** and the plastic helix **12** are being co-extruded from two separate extruders **9** and **10** via a single combined tool die **8** with three (3) separate orifices. As illustrated in **Figure 2**, there is one orifice for extruding plastic ribbon **11**, with the plastic ribbon **11** helically wrapped around the mandrel **7** such that its edges overlap and is simultaneously bonded by heat together to form the wall of the flexible tubing **14**. The mandrel **7** rotate in unison in an anti-clockwise or clockwise direction (depending on the machine setting) with advancing forward vector force concurrently to form the base material for the flexible tubing **14**. Concurrently, there is a second orifice for feeding the electrically conductive wire/s **13** through a wire insert via the back of the same combined tool die **8** directly connected to the extruder; and followed by overlaying the electrically conductive wire/s **13** coming out onto the extruded plastic ribbon **11**. By adjusting the lever handle **3**, the position of the roller **2** can then be adjusted such that it is in contact with the extruded helix **12**, and by virtue of pressure applied, transferring the image of the texture onto the extruded helix **12**. By adjusting the lever handle **3**, the amount of pressure to be applied can be controlled. Concurrently this pressure action will also enable the extrudate (helix) to have better bonding over the electrically conductive wire. This texturing action will have to be quick and done before the entire polymeric extrudate is cured and cooled in a water bath.

Therefore, the present invention presented an innovative method of creating texture on the surface of the medical tubing, especially more so on extruded medical tubing with textured helix of various different patterns, which has aesthetic appeal with potentially different color and is functionable, example with hydrophobic properties.

While what has been described hereinabove is the preferred embodiment of the invention, those skilled in the art will understand that numerous modifications may be made without departing from the spirit and scope of the invention. The embodiments described herein are meant to be illustrative only and should not be taken as limiting the invention, which can be expressly set forth in the following claims.

CLAIMS

What is claimed is:

1. A **method** for texturing on flexible tubing, whereby it comprises of:
 - (a) Utilising a roller die jig assembly comprising of
 - i. a roller with its surface having textures of various different patterns;
 - ii. a jig bar;
 - iii. a lever handle for adjusting and controlling the position of the roller;
 - iv. a lever handle that is able to adjust the left-right positioning of the roller via the jig bar; and
 - v. a base plate such that it can mount onto the extrusion machine;followed by
 - (b) Co-extruding the plastic helix and the plastic ribbon whereby the plastic helix is being overlayed onto the electrically conductive wire (with or without) and with the plastic helix being wrapped and heat-bonded around the plastic ribbon forming the flexible tubing; followed by
 - (c) Adjusting the lever handle such that the roller is in contact with the extruded plastic helix; and
 - (d) Transferring the textured image onto the extruded helix by virtue of pressure applied; and
 - (e) Concurrently this pressure action will also enable the extruded helix to have better bonding over the electrically conductive wire.