Typical Electrospinning Apparatus Parts

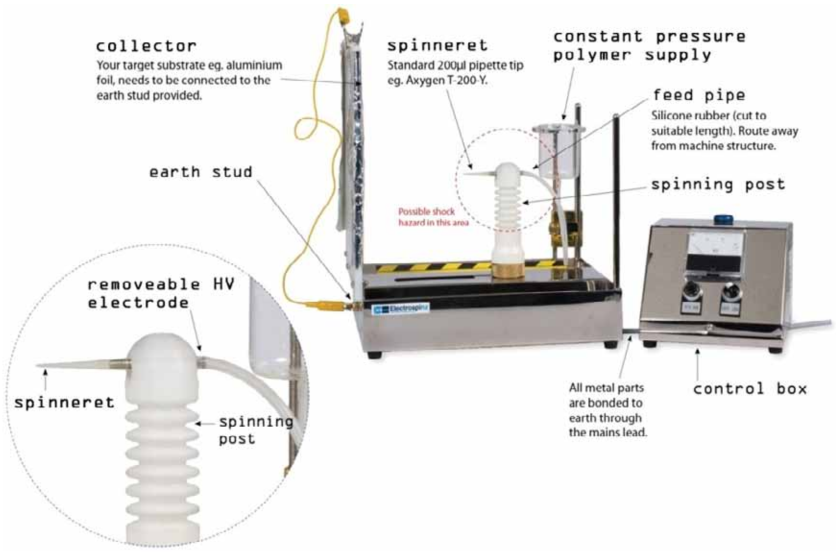

Figure 1: Image provided by Electrospinz Ltd. of their ES1a electrospinning platform demonstrating the key parts

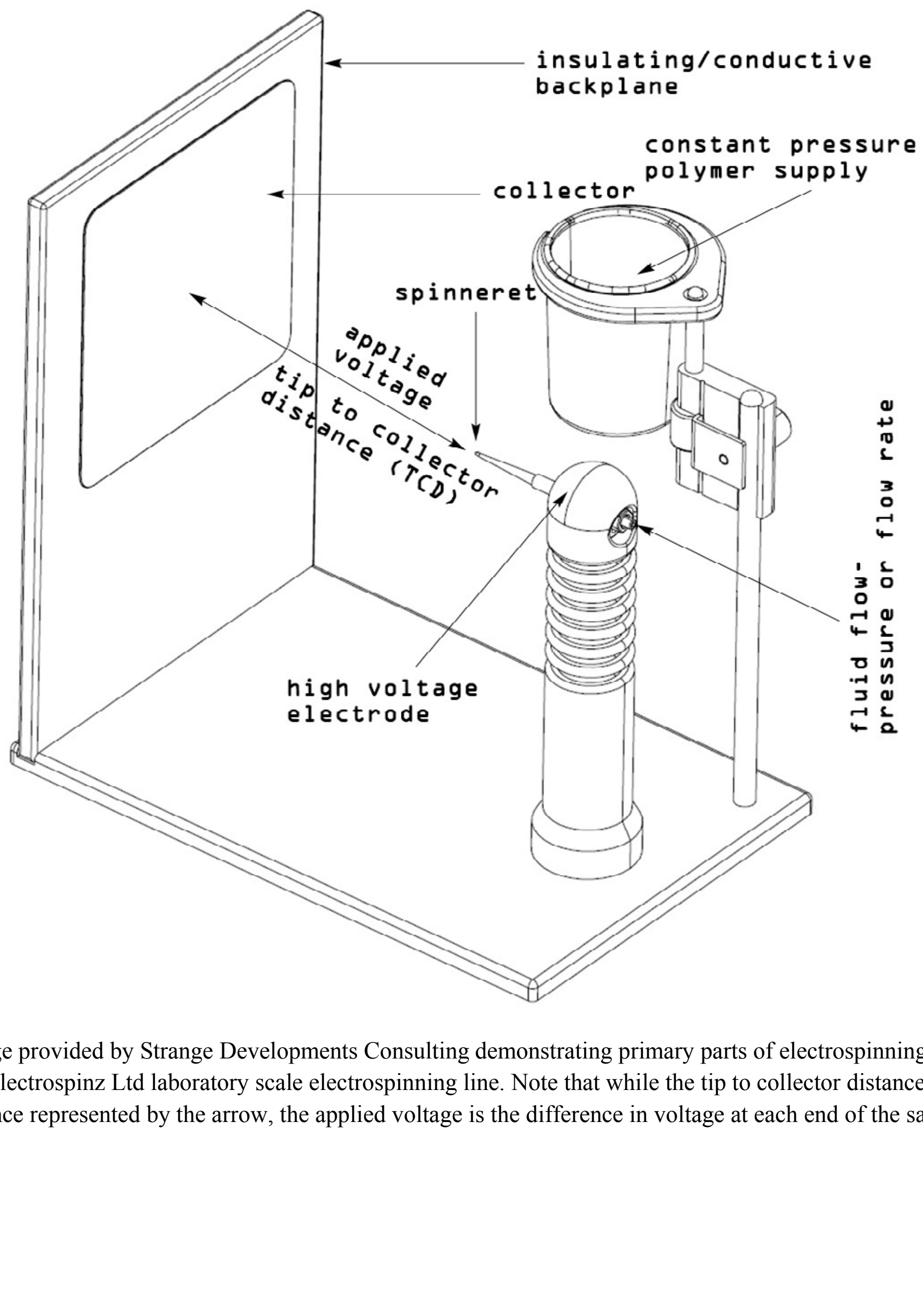

Figure 2: Image provided by Strange Developments Consulting demonstrating primary parts of electrospinning apparatus based on the Electrospinz Ltd laboratory scale electrospinning line. Note that while the tip to collector distance (TCD) is the physical distance represented by the arrow, the applied voltage is the difference in voltage at each end of the same arrow.

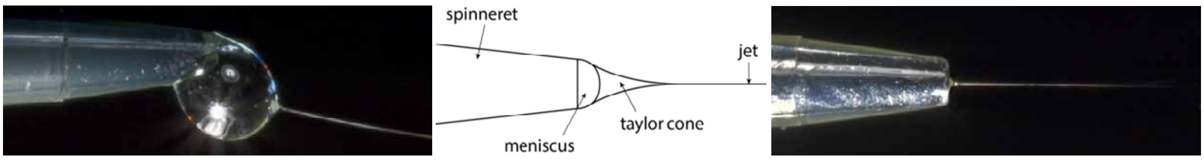

Figure 3: Taylor Cone Examples: Left - Spinneret with overfeeding Taylor cone; flow rate is too high. Middle - ideal Taylor cone; flow rate is matched. Right - Spinneret with underfeeding Taylor cone; flow rate is too low.

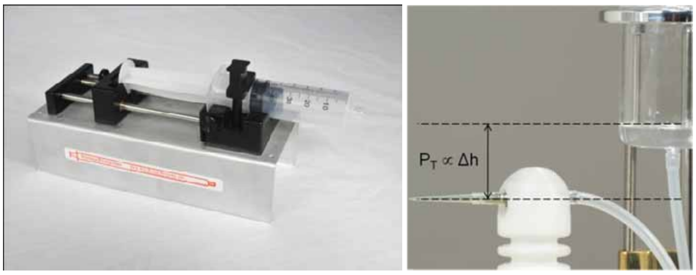

Figure 4: Polymer Supply Mechanisms: Left - Constant volume system; syringe pump, New Era Pump Systems Inc. model NE-500. Right - Constant pressure system; Electrospinz Ltd. ES1a header tank held at a height above the spinneret

Figure 5: Spinnerets can be either conductive or non-conductive. On the left is a non-conductive pipette tip and on the right is a conductive blunt end syringe needle where the needle may be used as the high voltage electrode. The middle shows the location of the orifice which is the point on the spinneret where the Taylor cone is formed.

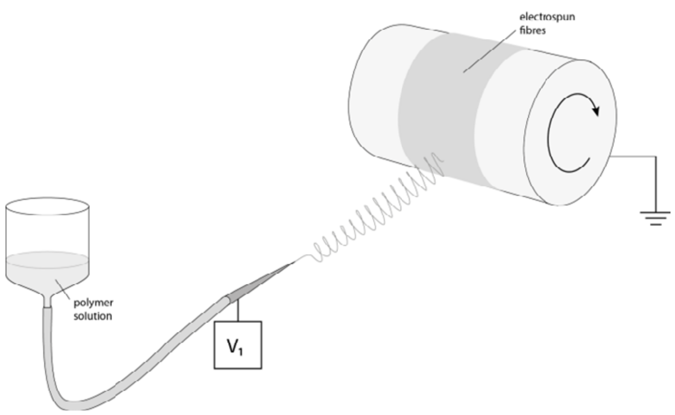

Figure 6: A common modification of the collector electrode is to replace the flat plate with a rotating collector. Often the rotating drum is metal and can be grounded to use as the collector electrode. A substrate can still be placed on the rotating drum to collect fibre.

Figure 7: Typical commercial high voltage power supplies will come in two styles. Either rack mounted as on the left from companies such as Spellman High Voltage Electronics Corporation and Glassman High Voltage Inc. or may come as potted in modules as on the right requiring external control electronics as those made by EMCO High Voltage Corporation.

A Standardized Descriptive Language of the Electrospinning Jet

When discussing the electrospinning process there is a difficulty due to the lack of a formal system of descriptive language for the appearance of the jet. The system outlined below introduces the required system in a sufficiently general way to allow a reasonable description of any jet formed during electrospinning and many electrospraying jets. This language splits any electrospinning jet into a series of regions typically starting with an *elongational flow* followed by a series of regions describing the *instability envelope*. The elongational flow region can be *directionally stable or unstable* and it may *precess* around the central axis between the two electrodes. The elongational flow region can also be described by its *length*. *Multiple jets* can be formed in some cases. If these jets have a different appearance then the largest jet will be designated as the *primary jet* and other groups of jets will follow a decreasing size convention.

The instability region is divided into a series of simplified shapes, either *a conical or a cylindrical region*. A conical region is described by its angle (*acute or obtuse*) at the onset of the instability. When a conical region does not directly follow the elongational flow region the angle is measured at the point where the two sides would meet if they were extrapolated back i.e. the apex of the cone. If the conical region is not *straight sided* (i.e. a classical cone) it is a *conical flare* that may be either *concave or convex*. A concave flare will appear to be expanding and always has an acute angle. A convex flare will appear like a wine glass where the cone is collapsing towards a cylindrical shape and always has an obtuse angle. The cylindrical region is characterized by parallel sides and described by its width (*broad or narrow*). If the cylindrical region directly follows the elongational flow it is described by the angle (*obtuse, straight i.e. 180° or reflex*) at the onset of the instability otherwise it has no angle. There are conditions where the final region before reaching the collector may become impossible to observe visually (either by excess thinning or breaking up into droplets) and this special case is labelled as *invisible*.

An example of this system might be the formation of two different jets, the primary having three regions with the secondary having two regions. The primary has a long elongational flow followed by a reflex angle narrow cylindrical region that transitions into an acute conical region. The secondary has a short elongational flow followed by a concave conical flare.

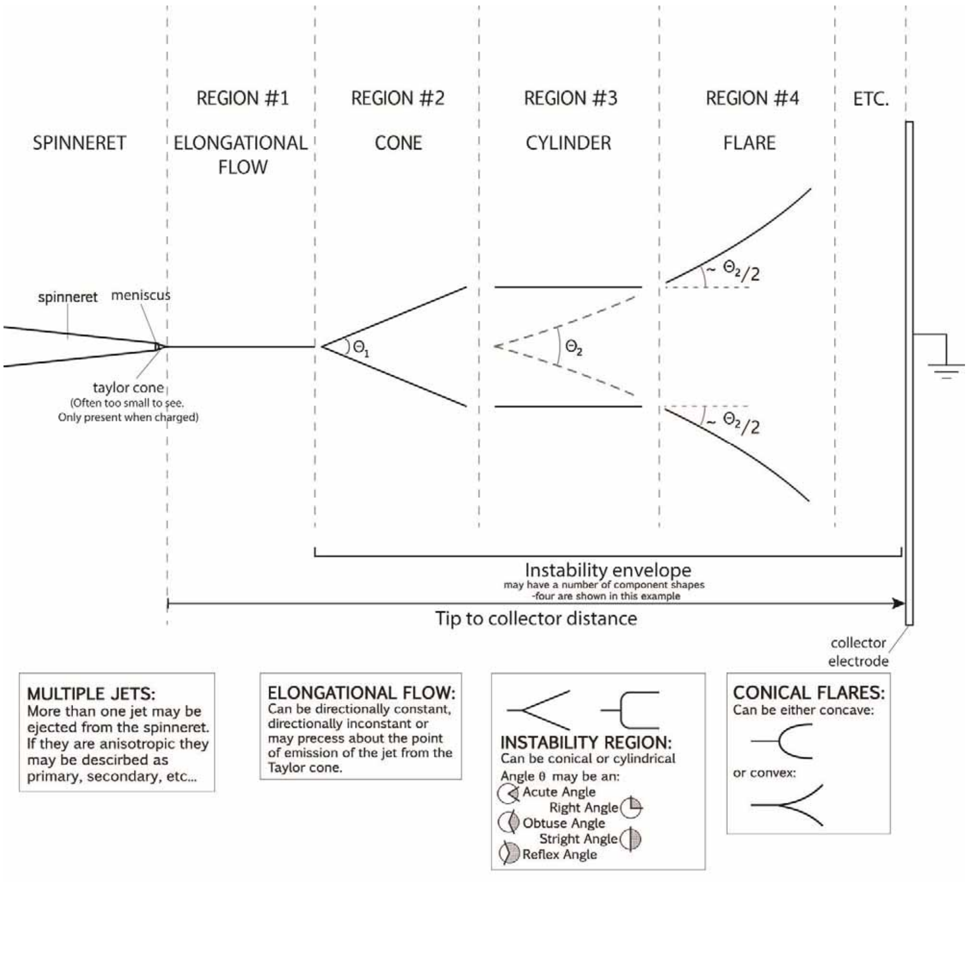

Figure 8