Polydimethylsiloxane (PDMS or silicone) is an important and versatile material used in the field of printed electronics (PE). In particular, thin film layers of PDMS show great promise for use in printed electronic devices for sensing, monitoring, and biological applications, among others.

However, current manufacturing technologies such as spin coating, casting, and molding lack sufficient capabilities to produce PDMS film devices in large scale or at high speeds. Such methods also require special handling and multiple steps that can give rise to quality control and throughput challenges. Because of these cost and reliability issues, some electronics applications will be inhibited from reaching widespread commercial deployment.

Accordingly, the ability to manufacture and print large area, thin PDMS films at high processing speeds, especially while minimizing the potential for damage or contamination during subsequent device processing steps, would enable higher production yields and increased throughput. Such processing technology would substantially improve the ability to produce printed electronics at the desired economies of scale, enabling numerous affordable applications. In some cases, it may also be advantageous for certain layers to be more readily separable from a base layer or substrate as compared with conventional technologies.

**Technology Description**

At WMU, a roll-to-roll (R2R) process for manufacturing thin PDMS films has been developed, which enables high throughput and large area printing of electronic devices. Moreover, the PDMS films developed can be as thin as about 25 microns, a substantial improvement over existing techniques. Example PE devices include flexible and/or stretchable electronic circuits, sensors, actuators, generators, microfluidics, biomolecule patterning stencils, and tissue scaffolds.

The WMU R2R process adapts several techniques used in the paper and film printing industry, such as coaters, curing ovens, drying ovens, and chill rolls, and combines them with functional material printing capabilities (Fig. 1 on next page). Accordingly, a variety of layer types can be deposited in various configurations including substrate layers, sacrificial layers, separation layers, functional layers, support layers, surface treatment layers, encapsulation layers, etc. (Fig. 2 on next page).

Examples of materials found in functional layers include conductors, conductive elastomers, dielectrics, adhesives, functional inks, metals, alloys, etc. Encapsulation layers will typically be made of another PDMS film. With regard to the substrate, in some applications it is desirable to incorporate sustainable materials, such as pulp/paper substrates or PET substrates, among others.

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As for the separation layer, using a dissolvable material can aid the separation process and also facilitate recycling. Water soluble examples of this “sacrificial” layer include polyvinyl alcohol, sodium alginate, ethylated starch, and carboxylated soy protein.

Potential Benefits
• Allows for high speed, large scale production of printed electronic devices
• Is ideal for producing thin PDMS films down to 25 microns
• Facilitates recycling by incorporating a sacrificial, water soluble separation layer

Figure 1. Example Process Flow

Figure 2. Example Device Schematic