

Stretchable Inks: Changing the Wearables Market and the Landscape of Manufacturing



Steven Willoughby

I spoke with DuPont's Steven Willoughby and Michael Burrows recently. We discussed new material for wearable electronics: stretchable inks. Wearable electronics is a fast growing sector of the electronics industry that is inspiring new and exciting products, as well as changing the requirements for becoming an electronics manufacturer.

Barry Matties: Steven, why don't you start by telling me a little bit about this technology?

Steven Willoughby: I'll start with a little bit of background. Our stretchable electronic inks for wearable electronics make smart clothing essentially more functional and more comfortable. What these inks do is allow a manufacturer to create a circuit that can be seamlessly fused with any standard fabric, allowing for unprecedented comfort and freedom in a wearable electronic design. This is really a step forward when you think about embedding electronics in clothing, in that it is very thin. It is also highly manufacturing-friendly and functional.

Matties: Do you see this in a military application or is this strictly for consumer?

Willoughby: We are certainly talking to people across a variety of different applications that have interest in using these inks, but when you think about the properties, the stretch-ability, the wash-ability, and the other attributes of the ink, you can see them used in a fairly broad array of applications. Certainly a lot of the early interest has been in consumer applications, but I wouldn't say that is the only segment looking at it.

Matties: What does the typical manufacturer look like? Is it a traditional circuit board fabricator or is this a new breed of manufacturer that we are going to see crop up around this technology?

Willoughby: I think that the answer to that would be both. We are seeing people coming both from more of a traditional apparel background, who are more interested in the clothing side, and we are also seeing people who are associated with the circuit board side. It is a bit of a new space with a new value chain, but people from both spaces are interested in these materials.

Matties: Do you think this market space is worth billions of dollars?

Willoughby: Well certainly there is that potential in smart clothing. Mike can probably speak a little bit more to that market dynamic.



Michael Burrows: For textiles, depending on what you include as a smart textile, you can already calculate it to over a billion dollar market and this would include other DuPont materials like Tyvek and Nomex, which is a material used for firefighting or chemical resistance. If you include that kind of smart clothing then, yes, it's over a billion. However, if you are exclusively including electronically

functional smart clothing, the market is quite a lot smaller than that and our estimates would put it even below a hundred million today.

Matties: So what sort of electronics would someone be utilizing with these inks? Would it be sensors and body temperatures, and that sort of thing? Where is it headed?

Willoughby: As far as some of the things you have described, certainly we are already seeing some very innovative applications in things that use different types of sensors. You mentioned body sensors. They look like your EKG sensors, measuring temperature, etc. We are also seeing some folks doing fairly innovative things with force and pressure sensors. Beyond that, you can imagine when you think about the ability to put a stretchable electronic element onto a fabric or into a clothing application, that you could quickly see a lot of other fairly innovative and creative opportunities. Some of the folks that we are working with can't necessarily share details of their applications.

Matties: I see that it is good for a hundred washes in most applications. At that point is the product basically a throwaway?

Willoughby: I wouldn't say that is the case. Again, what we have shown through working with partners is that the materials can survive a hundred wash cycles, but really there is a pretty minimal impact in performance at that level..

Burrows: I agree; that is a good characterization. From our information so far, the failure modes that one would expect for a smart shirt with our ink card are the same failure modes of a typical shirt without any kind of electronic functionality. Shirts wear out at the regular seams or get pinholes, etc. But the inks are surviving past a hundred washes, which is a key threshold in the industry. At that point, any part of the shirt or garment could start falling apart as per normal experience.

Matties: Are there other applications, such as outdoor equipment like tents, for built-in light systems and things like that? Are you looking into markets along those lines as well or are your customers looking into those types of markets?

Willoughby: I don't know of anyone who is working specifically on tents in our customer pool, although I can't say confidently that no one is. But certainly the breadth of applications that people are starting to look at for this is broader than we had initially anticipated. We have found some folks with some very interesting, very creative ideas.

Matties: Where are you seeing the majority of the interest? Is it in Asia or America, or is it kind of equal?

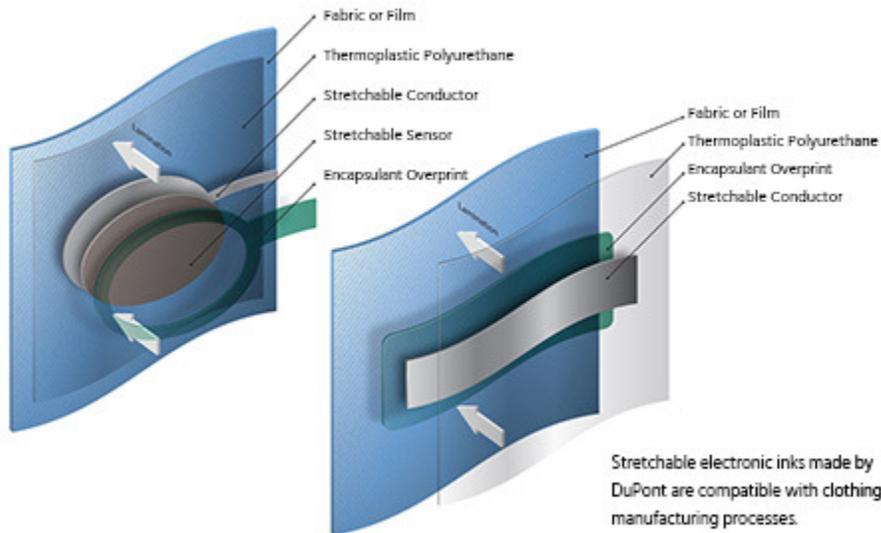
Willoughby: My sense is there is somewhat of a global balance, maybe a little more in the few regions you are describing with maybe a little more in the U.S. Mike, you are probably closer to that. Is that a good characterization?

Burrows: Yes, but in Europe as well. Earlier, we talked about some of the applications. For consumer, military and also medical, throughout the globe there are centers of competency in all of those segments, but pretty evenly distributed through those three main regions. It is really well-balanced right now and the textile industry has extensive presence here in the U.S. and Europe, a large manufacturing base as well as a large presence in Asia. So we really are feeling a pull from the industry around the globe.

Matties: What sort of sales are you guys experiencing now with your products?

Willoughby: We are not necessarily ready to give specific sales figures, but we are very excited by the level of interest we have had by both manufacturers and OEMs in the product. We feel very positively about the direction it is going.

Matties: I am curious about something. Are you seeing a big spike in interest and people who are rushing to get into it, or is it more of a wait and see attitude and let the early adopters pioneer this technology?



Willoughby: I would say we have very strong and broad interest in this offering at this point. It has been very exciting for a number of our customers.

Matties: In order to lay the circuits onto the film or the fabrics, is that done with a printer? How does the process work?

Willoughby: It is a pretty straight forward situation. This is actually a manufacturing-ready solution that uses common manufacturing

processes from the garment industry. In the application as shown in the figure above, we are actually printing onto thermoplastic polyurethane (TPU) using screen printing, which is a standard technology. It has been around for a while. Clothing folks are very familiar with that.

Some of the other processes that are used for interconnects, which are a very popular snap solution, a lot of these also can be done using standard clothing processes and standard clothing equipment.

Matties: That's great. No equipment investments necessary?

Willoughby: That's right. At the very least, that equipment exists in various locations in the industry. I mean, any given facility may need to add something, but all of it is comfortable, familiar equipment that they are using in the industry.

Matties: If someone with the equipment in place wants to turn this part of the market segment on, they simply need to order your products and they can do that pretty easily?

Willoughby: Essentially, yes. There is some design know-how that goes into it, but from a manufacturing standpoint it is very straight forward.

Matties: You mentioned the design. Is this something that we are going to see come into mainstream circuit board designers, or is this going to be a whole new breed of designers who will be coming out with these? I ask because they are relatively simple circuits as far as I can tell.

Burrows: There are a lot of specialty skills involved because the interaction with the fabric adds a whole new dynamic to the design. It is kind of a new breed of designers that are getting involved.

Matties: That is interesting because there is a lot of talk today about what is going to inspire young people to enter into the circuit or electronics design community. And I think it is going to be products like this that certainly could be a path forward into our industry. Some will stick with the wearables and some may move on to more complex designs. It is nice to see a product that is perhaps appealing to a new segment of designers. Are there other competitors already out there in the marketplace with products?

Willoughby: There certainly are other technologies being used to create smart clothing. There is conductive fabric out there. There are various electronic yarns that are woven in. What we are finding is that these inks have significant advantages in terms of comfort, thin form-fitting circuits, user manufacturability and, in many cases, performance. So we do think these are compelling solutions for making these circuits, versus some of the competitive alternatives that are out there.

Matties: Congratulations. It looks like really interesting technology and the potential for a nice piece of market share. Thank you very much. I appreciate your time today.

Willoughby: Thanks, Barry.