Mechanical endurance testing for
Ultraviolet and Electron beam components in flexible electronics

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An important growth driver for all those involved in UV and EB technologies has to be the promise of flexible hybrid electronics. What is significant at this particular moment in time, is that we are beginning to see real consumer and industrial demand for these new products which translates to real opportunities for all of us. The mere fact that there is large participation is a reflection of this sentiment.

Flexible electronics seems somewhat self-explanatory. The hybrid aspect reflects also new attributes such as stretchable, conformable, transparent, biocompatible and lightweight materials. It is an interesting time as interdisciplinary skills are required to develop these new products.

From a supply chain perspective, those focused on UV and EB and therefore curing, is represented in encapsulation which obviously takes place after assembly. Product testing, from a traditional perspective, occurs afterwards. However, testing with new performance criteria, testing should not be an after-thought and engineers should design-in these new performance criteria to add value and develop a more robust end product.

Market pulled applications can range from increasing smartphones with foldable tablet capabilities, wearable and medical devices powered by AI intelligence, voice recognition speakers and smart home IOT devices, e-textile and sportswear, industrial construction sensors, agritech, automobile, aerospace and defense. All have different performance requirements.

Take for example, wearable products. From our experience with working with a number of leading consumer electronics and sports apparel manufacturers on the West Coast, we can deduce that the main challenges are to move comfortably with the human body yet working with rigid electronic assemblies, working with small components and wiring, let alone safe energy harvesting and generation.

Translated, new testing requirements for all UV and EB components requires an understanding of flexing or folding, stretching and twisting & bending. In the past, most stand-alone action only measures the point of failure, but not how a material evolves over time, and this endurance testing is a fundamental philosophical departure from the past.

At this point in the manufacturing development of flexible electronics, we have depended on three industries which are converging to meet this need. From the world of semiconductors who bring nano-level precision and cleanliness, from rigid board PCB who place emphasis on conductivity and materials, and the mass scale from Consumer Electronics.

Simultaneously we are seeing additional market accelerators, such as agreed upon industry standards such as WEC and IPC and more and more, de-facto standards as required by the largest consumer electronics companies for their exacting specifications. A best-of-breed approach seems to make most sense to capture these two efforts.

So, initially we look at the specific mechanical challenges of flexing. If you take a substrate and fold it like an omelet, we discovered that there is additional stress during the initial bend and secondly, there is increased friction at the edges when you move up. We overcame both by using a system of mechanical pulleys to eliminate counter-weights and place the test in a more neutral friction position from on its side to the bottom. This is what we call our patented tension-free processes.

One requirement for flexing was to move the sample substrate like a wave being pushed along. The flexing is concentrated in the middle and is a good representation of e-textile use. We will show a series of videos to demonstrate this and following testing procedures.

Another requirement for flexing was to have a fixed pivot much like how your elbow will move has been used in smartphones and wearable product development to simulate folding phones with hinges.

With regards to stretching, the requirement is to fix a sample at one point and have a moving motion, with various degrees of pull strength.

Twisting can be done for individual and bundled wires, or with planar samples and by fixing one end and rotating the other, we can accommodate this.

In conclusion, we will introduce our results of various failure modes such as cracked, delamination, bent, stretched, torn with various mechanical methodologies as introduced above.

US owned BAYFLEX SOLUTIONS, takes off the shelf YUASA SYSTEM endurance machines (over 120 configurations of power drive and mechanical jig units) and adds electrical & optical testing data measurement software systems and in-market capabilities. We have installed in ambient conditions and various hostile environments in North America and Europe.

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Powered by AI driven services, it is an interesting time for engineers and designers involved in flexible hybrid electronics, specifically in sensors, wearable devices and e-textiles in wellness, medical, sportswear and military applications.

Specifically, this topic is of interest to anyone involved developing multi-layer products such as display screens, covered glass and plastics, metal ink compounds, adhesives, bendable batteries, connectors, cables and soft antennas.

Legacy rigid state design practices are insufficient to meet the requirements of flexible. stretchable, conformable, transparent, biocompatible and lightweight materials. Innovators will require new test methods to design continuous and lasting mechanical performance into their product designs, as well as new methods for testing those new products.

What will be needed is a series of unique, scalable, and modular mechanical endurance testing solutions for ambient and hostile conditions, with the added ability of measuring the performance of the flexible components throughout the complete enhanced testing cycle.

Those testing solutions may include, as examples, stretching, flexing or folding, twisting, and bending mechanical jigs. You may wish to increase the stress during testing to the breaking point, to determine the limits of the components. And you may wish to use equipment that allows you to test twisting, for example, without tension to reduce counterweights and better understand how the component reacts to different types of stress.

The solutions should provide the capability of simultaneously making measurements of resistance, temperature, tension, capacitance, etc., of the components as they are undergoing testing in order to provide information that can be used for worst-case design.

In short, testing device performance should not be an after-thought and engineers should design in during initial product development to create a more robust service.