Development of double-curved electroluminescent surfaces

Rutger D. Frieswijk
Industrial Design
Faculty of Engineering Technology
University of Twente, Netherlands

Advertisements with the use of light, so-called electronic signage, is widely used today. Branding companies are interested in a system that could replace the current electronic signage with a more efficient form of signage with the use of light to brand their clients.

With the question in mind to make a more efficient form of electronic signage has Parthian Technologies B.V. partnered together with Anker Stuy Verven in the shape of a new company, Xcite Solutions B.V.

Since the current electric signages have all sorts of shapes and to enhance the market dynamics for a new signage system, Xcite wants to make the electroluminescent product which are deformable over multiple axes, e.g. as a sphere. Because this principle is still in development, it is a suitable subject for a bachelor thesis.

The current system, electroluminescence and thermoplastics have been analyzed. This showed that electroluminescence, in the system of Xcite, uses four critical layers and an alternating current, existing out of thermoplastics, except the two outer, conductive layers. These two outer layers exist out of copper and are thus not deformable in the same way as the other layers in the material. The electroluminescent material as a whole can be observed as was it a capacitor. Wherein the material between the two outer layers is the dielectric.

Because thermoplastics have the property that they can be deformed after production, for example, by using a vacuum former machine, the whole electroluminescence material is tried to be made out of thermoplastic layers. Besides, the conductive layer has to be light permeable, as the inner two layers cause the light emittance. Therefore the conductive layer must be (semi-)transparant.

The only disadvantage with thermoplastics is that they are not conductive. Ameen, Ali, Zulfequar, Haq & Husain (2008) show that it is possible to make a conductive and thermoplastic film, based on a thermoplastic polymer, compounded with polyaniline (PANI). These films are promising, but not conductive enough. Therefore more research has been done in the field of carbon nanotubes and silver nanowire. These nano-materials can be added to a polymer to enrich it with more properties or change the behavior.

Carbon nanotubes are great for the enhancement of thermoplastics to make them conductive, but the disadvantage of carbon nanotubes, is that they are black and cause the polymer to get less transparant. Silver nanowire on the other hand is much more suitable for making transparent and conductive polymers. Xu & Zhu (2012) made a highly-conductive material based on Polydimethylsiloxaan (PDMS). This material has a conductivity of ~8,130 S/cm, which is about a factor 40 less than the copper conductive layer, but is better than a polyaniline based polymer. Because copper still seems to be the best solution, some experiments are needed to test what is the best way to use the copper in a material that will be deformed over multiple axes.

Finally, the deformation is being researched. The current materials exists out of multiple types of polymers and copper layers. Based on the glass transition temperature can a temperature be determined at which the thermoplastics are optimal to deform in a certain shape, by using, for example, a vacuum former machine or any other pressure applying machine that can push or pull the thermoplastic layers. It is expected that a copper layer can be deformed with the same technique as the thermoplastics, because it is pre-processed in a certain way. Although, the copper will not be thermoformed, but cold deformed by using pressure. It is assumed that a greater force is needed to deform the electroluminescence material including the copper.

Since the experimental plan has not been achieved, an in-depth literature study has instead been done and experts in the fields of polymers, conductive polymers and deformation of metals have been interviewed. This revealed that there are alternatives for a conductive layer, like a polymer material enriched with silver nanowire. If this alternative is transparent and conductive enough, remains a question to be answered. But the current copper layer is, at least, for non-double-curved surfaces probably the best, as it is highly conductive and can be made semi-transparent.

It is recommended that a silver nanowire enriched thermoplastic alternative will be investigated further to test if it is conductive and transparant enough. Secondly, differently pre-processing the copper could lead to better results, but this is still to be tested.

I. Ameen, S., Ali, V., Zulfequar, M., Haq, M. M., & Husain, M. (2008). Electrical and spectroscopic characterization of polyaniline–polyvinyl chloride (PANI–PVC) blends doped with sodium thiosulphate. *Physica B: Condensed Matter*, *403*(17), 2861-2866. DOI:10.1016/j.physb.2008.02.025

II. Xu, F., & Zhu, Y. (2012). Highly conductive and stretchable silver nanowire conductors. *Advanced materials*, *24*(37), 5117-5122. DOI:10.1002/adma.201201886