Implementation of Inkjet Printing in Emerging Textile based Smart Applications

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Inkjet printing based production processes show an increased use in different fields, such as printed electronics, sensors or tissue engineering. Inkjet printing is the process of dispensing extremely small droplets of liquid ink onto a substrate.
Within the scope of this research, the printability of conductive tracks onto textile is investigated. SS 303 (Ten Cate AC) glass fabric is used to simulate a textile based substrate. Different pre–treatments are applied, microscopic pictures are taken, the wetting behavior is analyzed and the results are discussed.
Two are the proposed pre–treatments in order to avoid the spreading of the ink between the fibres. The first substrate is modified with hexamethyl disilazane (HMDS) for hydrophobization while the second substrate is modified using a combination of HMDS and Teflon AF.
The dynamic wetting behavior of the droplet show the three regimes of the wetting behavior on the unmodified glass fabric, while in the modified glass fabric penetration is avoided because of the hydrophobic coating created on the surface by Teflon AF and HMDS (figure 1).

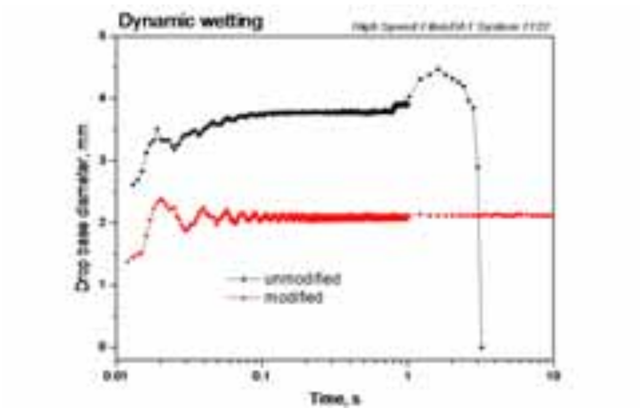

Figure 1: *The dynamic wetting behaviour of a droplet on a modified and unmodified glass fabric.*

In order to prove the principle, a strain gauge is printed and its performance is analyzed. The tensile tests serve to evaluate the sensor performance; first of all, showing if the sensor works correctly and at the same time, showing if almost identical strain gauges work similarly. The sensors studied in this research were printed on FR4 (Nelco N4000–6 FC) substrate. Identical printing parameters as well as the same thermal sintering process were executed with the purpose of investigating the reproducibility of the process.

The application force was fixed at 500N. figure 2 shows the performance of a printed strain gauge comparing with the values measured by an extensometer. The results illustrate an identical inclination, which means that the performance of the strain gauge is reliable. The difference on height for the lines is due to an offset measuring the applied loading.

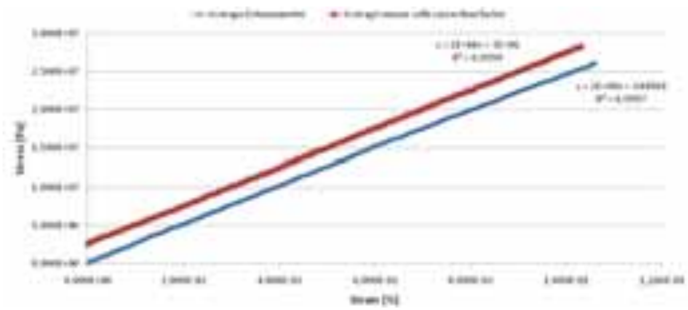

Figure 2: *Comparison between what the strain gauge measures in average and what the extensometer measures in average after applying the correction factor to the sensor.*

Fundamentally, all strain gauges are designed to convert mechanical motion into an electric signal. A change in resistance is proportional to the strain experienced by the sensor. Therefore, the gauge factor (GF) is related with the sensitivity of the sensor.
Slight differences on results are caused by the GF. An average value of 4.83 is obtained during the tests (figure 3). The GF in a big portion is dependent on strain gauge dimensions. Although the value is high comparing with commercial strain gauges (1.09), the room of improvement is very high.

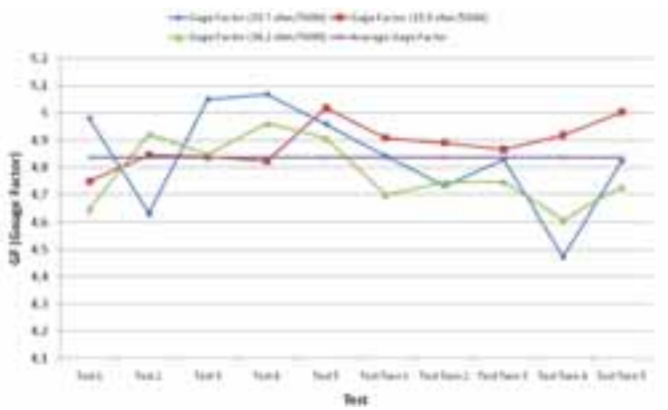

Figure 3: *Characterization of gauge factor within all the tests carried out at 500N.*

This research was a starting point on proving the principle that inkjet printing can be implemented in the manufacturing process of textile based smart applications. Despite the good results achieved during tensile tests, more tests involving different materials and cycling test are being performed. The cycling test will lead to find the limitations of the printed structures. Furthermore, the next step of this research will permit the development of a smart composite structure.