Investigation of Nozzle Height Control to Improve Dispenser Printing of E-Textiles

Tom Greig*, Russel Torah, Kai Yang
School of Electronics and Computer Science, University of Southampton
*tg8g16@soton.ac.uk

Introduction

Dispenser printers use a robotically actuated nozzle and pneumatic pressure controller to apply pastes to a substrate [1]. This technique is very versatile, allowing dispenser printing to be used on a wide variety of materials including uneven textiles and adhesive materials. It also trivial to change the printed design making dispenser printing an attractive platform for E-textiles prototyping and bespoke manufacturing. However it is very important to accurately control the clearance of the nozzle, which is technically challenging on uneven substrates.

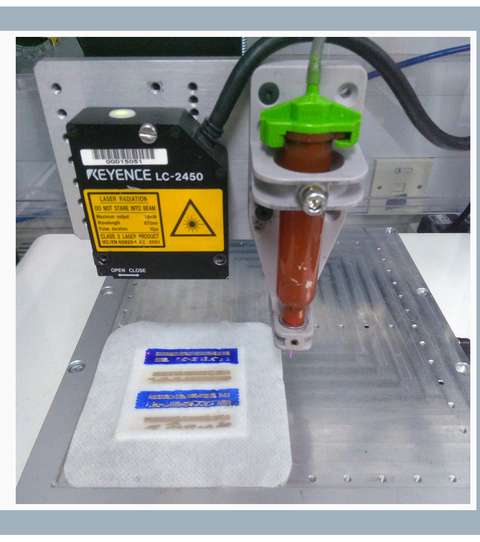

Fig 1. Dispenser printer with laser mounted on the left side of the head, nozzle on the right side

Problem and Objective

- Trace conductance increases with clearance up to around 200µm as thicker lines of paste are deposited (fig. 2). Beyond 250µm, the printer is unable to produce a continuous line and simply deposits one blob at a time (fig 3).
- Because of this, it is necessary to measure, and have the printer compensate for, any changes in substrate height that are larger than this range.

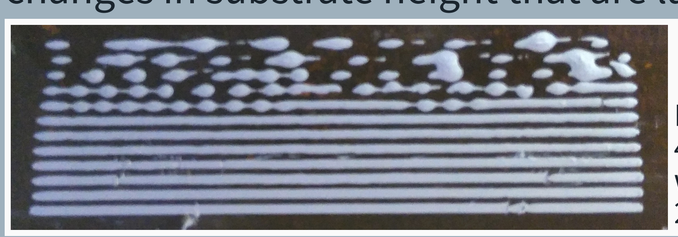

Fig 3.
40mm long test traces printed with on smooth kapton film with clearances of 0µm (bottom), 10, 25, 50, 100, 150, 200, 250, 300, 350, 400 & 450µm (top)

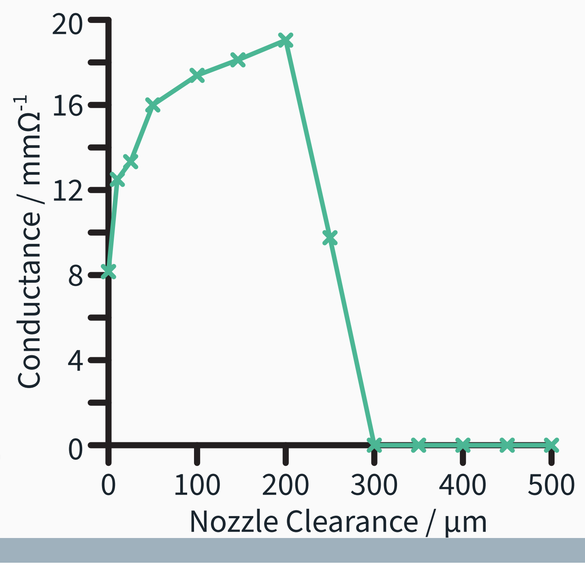

Fig 2.
Change in trace conductance with nozzle clearance.

Laser Profiling

- The Keyence LC-2450 laser used here struggles with materials that allow light to penetrate into them. This includes loose textiles and the FabInks interface layer [2] shown in the left side of figure 4.
- Testing on various concentrations of dye (Fig. 4) showed that 1 layer of interface with 20mg/g of blue dye gave the smallest error (Fig. 6) as well as giving the smallest variation in error.
- Adding coloured dye to the interface paste can reduce error, but beyond a certain concentration, makes the surface too dark to reflect the laser causing the error, and the error's variance to increase again.

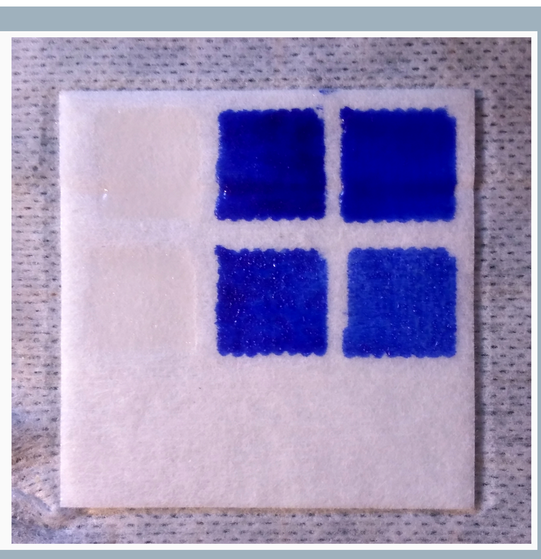

Fig 4.
Laser profiling test surfaces. Top row: 2 layers of interface, bottom row: 1 layer. Left: no dye, centre: 50mg/g dye, right: 20mg/g dye.

Fig 5.
Laser profiling (bottom 3 lines on each strip of interface) provides more reliable printing than printing at a fixed height (top 3 lines).

Using a single layer of interface makes scanning more accurate, but doesn't provide as smooth a surface as two layers.

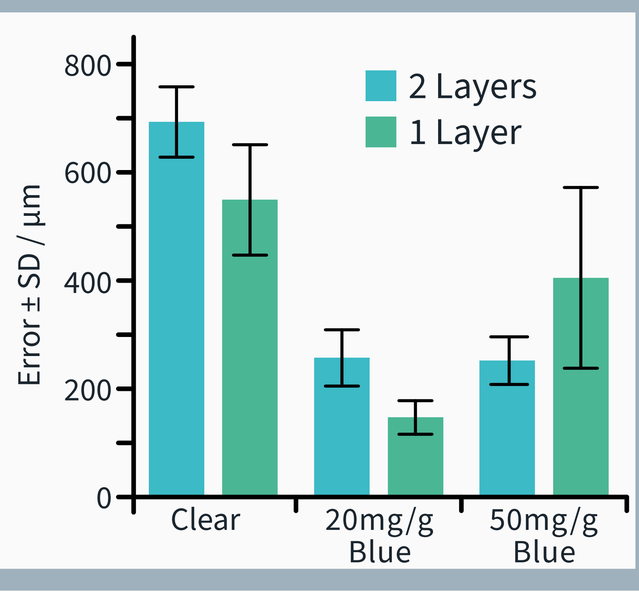

Fig 6.
Difference between manual touch-off measurements and laser measurements.

Conclusions

- Dispenser printing is a versatile printing method if nozzle clearance can be controlled
- Laser displacement measurement is a promising means of providing that control though care is needed to provide a surface that the laser can accurately measure.
- Translucent surfaces introduce a large error into the laser's measurements while excessively dark surfaces don't reflect enough light for the laser displacement meter to accurately detect.

References

[1]M. de Vos, R. Torah, and J. Tudor, 'Dispenser printed electroluminescent lamps on textiles for smart fabric applications', Smart Mater. Struct., vol. 25, no. 4, p. 045016, Mar. 2016, doi: 10.1088/0964-1726/25/4/045016.

[2]Smart Fabric Inks Ltd., 'Smart Fabric Inks Ltd – Smart Fabric Technology'. http://www.fabinks.com/ (accessed Oct. 22, 2020).