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Screen Printing on Low Temperature Cofired Ceramics

Camilla Kärnfelt[1*] and Nicolas Ryon[1]

[1]IMT Atlantique, Lab-STICC UMR CNRS 6285
Brest, France

Summary:

In order to improve screen printing quality of gold paste onto LTCC tape, an experimental design has been performed. The tested parameters, related to the EKRA M2H screen printer, are squeegee pressure, squeegee speed and snap off distance. Line widths and gaps sizes of 75, 100 and 150 µm were printed and optically measured in green state. The best setting, 30-45 bar squeegee pressure, 25 mm/s print speed and 0.7 mm snap off distance, results in an oversize of line widths and an undersize of gaps in the order of 15-19 µm.

Key words: Screen printing, Low Temperature Cofired Ceramics (LTCC), pressure, snap off, print speed

1. MOTIVATION AND DESCRIPTION OF WORK

The introduction of a new screen printer, an EKRA M2H, set off this work with the goal to consolidate the minimum line and gap widths for screen printing on LTCC tape in our laboratory [1]. The EKRA M2H machine involves parameter settings such as snap off, print pressure, print speed which have to be accommodated to a 7" × 8" screen coated with a 20 µm thick emulsion. We dispose of 325 calendered mesh/25 µm, with a 22.5° mesh orientation and stainless-steel wire. For this experimental design we use a 10 cm wide diamond shaped squeegee, ESL803 gold paste and 50.8 mm × 50.8 mm sized ESL41111-G tape provided by ElectroScience Laboratory (now merged with Ferro).

The test parameters are squeegee pressure (SP), print speed (SS) and snap off (SO) distance while fixed values are mesh type, emulsion thickness, pattern, tape and paste material and the operator. The result parameters are the measured line widths and gaps of a number of different structures, as can be seen in Fig. 1. The screen pattern contains lines of 75, 100, 150, 200 µm, with gaps of 75, 100 and 150 µm, as well as concentric circles having the same widths and gaps. To ensure a fair judgement throughout this analysis we only include the smallest lines and gaps (≤ 150 µm).

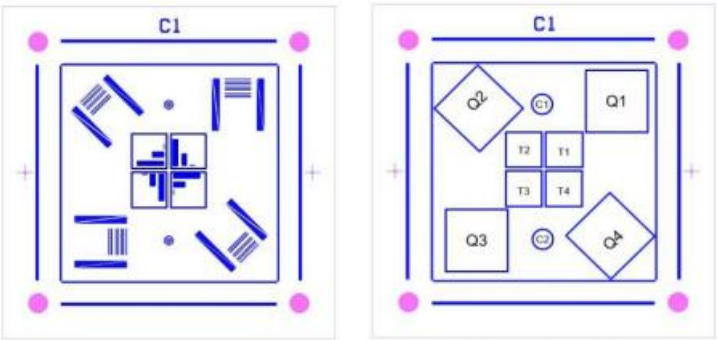


Fig. 1. Test pattern for screen printing, pattern (left), repeated patterns (right).

As presented in Fig. 1, the same pattern is repeated four times, which allows for us to calculate a mean value. This mean value's over- or undersize compared to the designed value is then given in percent. For both the line width and the gap size results, 100 % is the best possible value. The dimensional measurements were performed in a Leica S9D microscope with a Moticam series 5MP camera with associated optical measurement software. All dimensions are given in green state.

**Corresponding author: camilla.karnfelt@imt-atlantique.fr (Camilla Kärnfelt)*

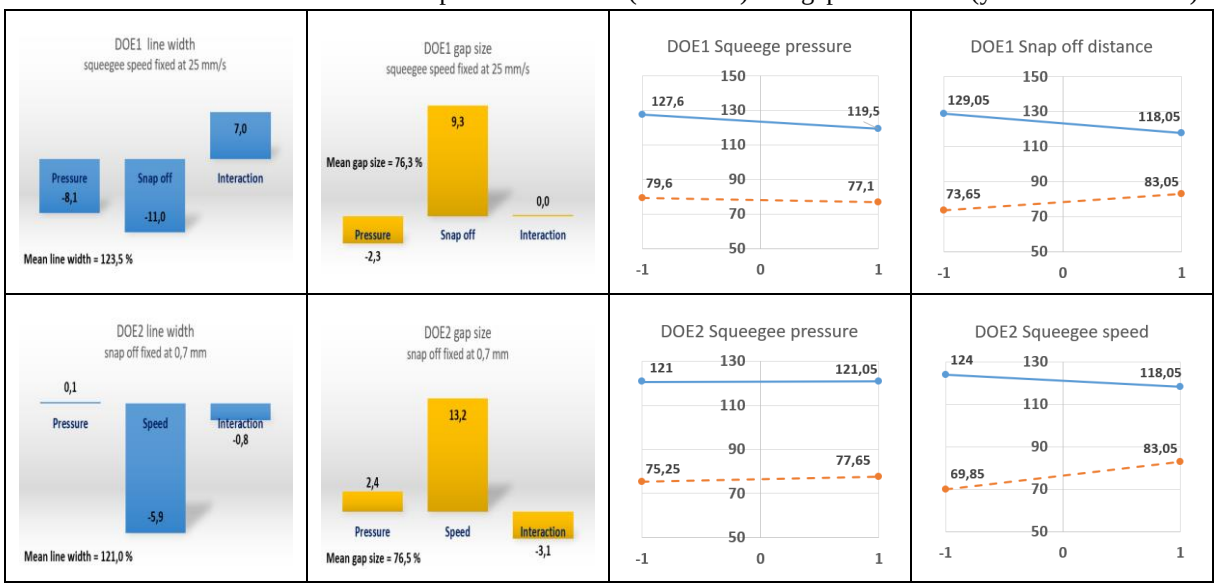
2. RESULTS

The test setups and results are presented in Tab. 1 while Tab. 2 shows the pareto and main effect plots.

Tab. 1. Results from variations of squeegee pressure, squeegee speed and snap off distance. DOE1 is for the case where the SP is fixed at 25 mm/s and DOE2 for a 0.7 mm fixed snap off.

DOE1 SP (bar)		DOE1 SO (mm)		Mean line width [%]	Mean gap size [%]		DOE2 SP (bar)		DOE2 SS (mm/s)		Mean line width [%]	Mean gap size [%]
-	30	-	0.5	136.6	75.0		-	30	-	10	123.4	66.3
+	45	-	0.5	121.5	72.3		+	45	-	10	124.6	73.4
-	30	+	0.7	118.6	84.2		-	30	+	25	118.6	84.2
+	45	+	0.7	117.5	81.9		+	45	+	25	117.5	81.9

Tab. 2. Pareto and main effect plots. Line width (blue lines) and gap size results (yellow dashed lines).



Analyzing the impact of the different factors, we find that to obtain the best results for both the line width and gap size, we should choose a high squeegee pressure, a high snap off and a high squeegee speed. However, when the snap off is fixed at its high value the squeegee pressure becomes non-significant, still, the significant squeegee speed should be set at its high value.

Looking at the line and gap dimensions individually, the best parameter settings (0.7 mm snap off and 25 mm/s print speed) results in 94 ± 5, 115 ± 7 and 167 ± 12 µm for the 75, 100 and 150 µm lines, and in 59 ± 4, 84 ± 9 and 132 ± 11 µm for the 75, 100 and 150 µm gaps respectively. In order to yet improve the results a 400-mesh screen or a before-printing adjusted design may be good solutions.

Acknowledgment

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3. REFERENCES

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** Corresponding author: camilla.karnfelt@imt-atlantique.fr (Camilla Kärnfelt)*