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Fine Pitch Paste Stencil Printing using Enclosed Printing Heads

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ABSTRACT:

This report contains a programme for future work for evaluating enclosed printing technology. The measurement methods are based on previous NPL measurements using laser scanning profilometry. The aim is to review the consistency in printing performance such as wet solder bridging, skipping, volume uniformity and environmental degradation of solder paste with the print head.

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Approved on behalf of Managing Director, NPL, by Dr C Lea,
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1 BACKGROUND

In the last two years, the major suppliers of stencil printing equipment have introduced enclosed print head as an improvement on squeegee technologies. Other companies following suit. These heads use a sealed reservoir of paste from which the paste is extruded by applying pressure to the top of the reservoir. The paste is retained within the reservoir by two wiper blades at the sides. A schematic diagram of a print head is shown in Figure 1.

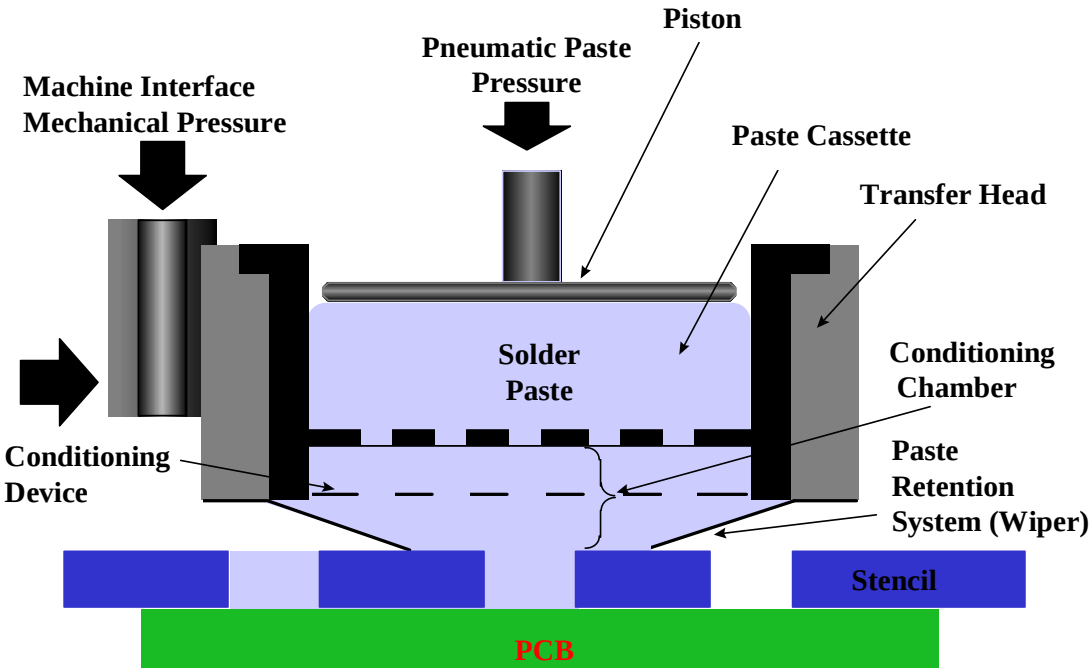

Figure 1 : Schematic of enclosed print head (source : DEK Printing Machines)

The advantages of the systems are claimed to be:

- less deterioration of the paste due to sealed environment
- less paste wastage (head can be left on stencil or sealed after use, thus no paste is discarded
- less bridging due to lower horizontal force component during printing

2 PROGRAMME

To evaluate the performance of these new systems and to determine the applicability of NPL's current measurement techniques, two investigations are proposed.

(i) Effects of Environment Conditions:

To determine the effects of environmental conditions on printing with the print heads the following programme is proposed:

The print head should be worked back and forth on a blank, supported portion of the stencil as in the diagram below. The stencil used should be a 100 µm laser cut with apertures in both orientations. The apertures should be 0.4, 0.35 and 0.3mm pitch and orientated as shown in figure 2, with 3 horizontal rows of each pitch and a vertical row of each pitch. The variation in alignment will allow checking for any differences in aperture filling between apertures parallel and perpendicular to the print direction.

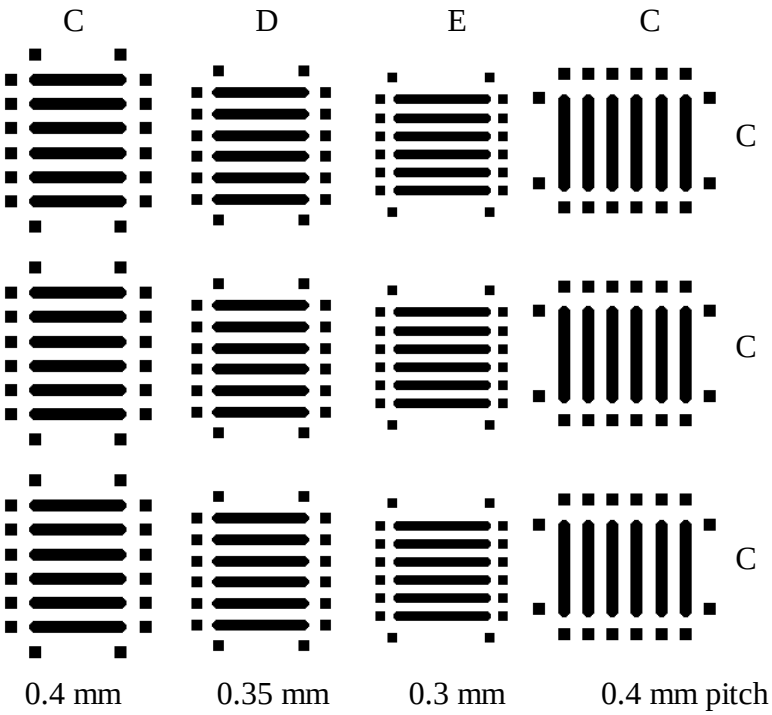

Figure 2 : Aperture Array

Each set of apertures should be repeated nine times over the print area in a 3x3 matrix to allow checking for any differences in aperture filling between arrays at the start and end of the print stroke and the left and right hand ends of the print head.

Printing should be undertaken on specially designed PCBs. PCBs are necessary because of the way that print heads work. It is believed that a print head creates a capillary gap between the underside of the stencil and the copper plate. During printing flux is drawn into this gap, probably assisted by the extra pressure on the paste in the print head. Paste particles follow the flux when the stencil is released creating bridging. This does not happen to the same extent when printing onto pads or printing with squeegee blades as the capillary gap is much shorter or exists for a shorter period. An example of a print on to pads is shown in figure 3. Here bridging can be seen where pads are connected and no bridging occurs where pads are separated.

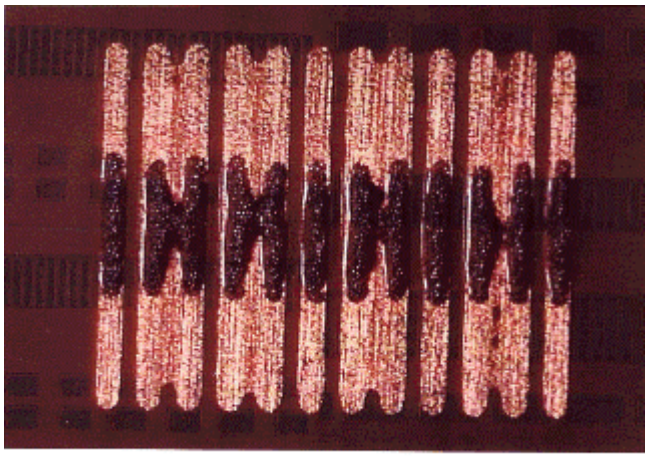

Figure 3 : Example of bridging on planar substrates

Extra pads should be incorporated on the PCBs at the end and sides of the pads corresponding to apertures to allow an easily measurable base height. A suitable arrangement is shown in figure 4.

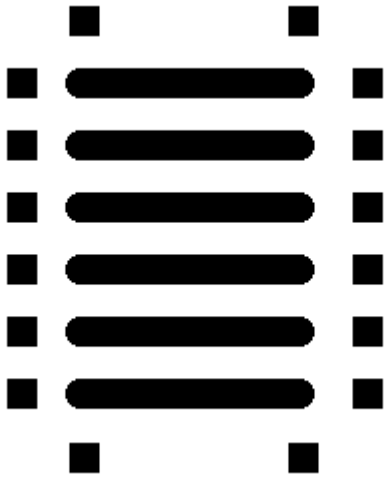

Figure 4 : PCB Pad Arrangement

Sample prints (last of six to ensure uniformity) should be taken every two hours for measurement of print volume, mean height and bridging. Paste flow should also be monitored using an under stencil camera. Two different SnPb pastes should be evaluated. A diagram showing print area in relation to conditioning area is shown in figure 5.

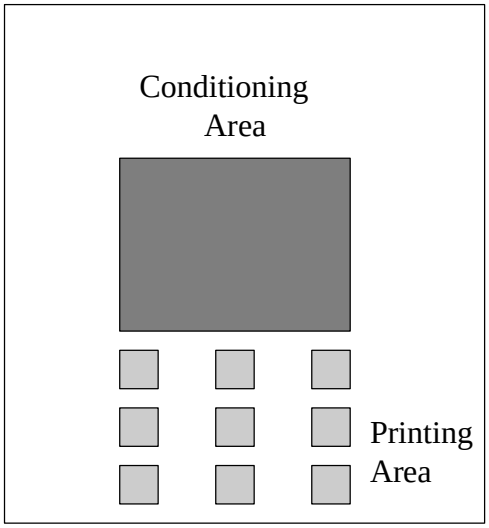

Figure 5 : Diagram showing Conditioning Area and Print Area

Initially measurements to be taken under worse conditions for squeegee blades 28 °C / 60 % RH. If these conditions create degradation with print head then other conditions will be evaluated (20 °C / 40 % RH, 20 °C / 60 % RH, 28 °C / 40 % RH).

Potential problems

Lack of paste movement within the print head may cause degradation of the paste during the working part of the printing. This would not normally occur in production as paste would be continuously 'lost' with each board printing and degraded paste would not be allowed to build up. To overcome this may require printing rather than working over the day. Cleaning this quantity of prints would be extremely time consuming so printing onto a disposable substrate (cling film), may be necessary.

3 PRINTING ON BENT SUBSTRATES

The rigidity of the print head design may cause problems with non-planar substrates. It is therefore recommended that the distortion evaluation from the last stencil print programme be undertaken using print heads. Printing should be undertaken on distorted copper clad FR4 on 0.5mm apertures in 150 micron stencil (distortion up to 1%) with two pastes (Sn60). Measurement of print volume, relative shape, bridging, viscosity should be undertaken as well as monitoring paste flow using under stencil camera.