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integration

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Citation International Exhibition and Conference for

the Printed Electronics Industry, LOPEC, 28

- 30 March 2017, Munich, Germany

Date 2017

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# Reliability of electrically conductive adhesive interconnections in printed flex-to-flex system integration

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# Introduction / background

PI-SCALE is a European collaboration to create an open access pilot line service offering world class capability in customised flexible organic light-emitting diodes (OLEDs) in order to accelerate the commercial adoption of this technology. The project brings together Europe's experts and state-of-the-art infrastructure for flexible OLED fabrication, and enables companies to quickly and cost-effectively test and scale up their flexible OLED lighting or signage concepts and bring them to a level where they are ready to be transferred to a mass production facility. The role of VTT in PI-SCALE consortium is to act as the system-level integrator for the launching OLED applications.

### **Materials and methods**

This study investigated the reliability of electrical interconnections when attaching roll-to-roll printed flexible conductors on PI-SCALE OLED foils containing circular contact electrodes of 8 mm in diameter. The test structures were manufactured with automated pick and place machine Datacon 2200 EVO (Figure 1) by utilizing a silver filled epoxy Epotek H20E (Figure 2). To obtain the optimal process recipe for the interconnection procedure, the following curing conditions were applied according to the adhesive manufacturer's specifications: 180 min at 80°C, 120 min at 100°C and 15 min at 120°C.

The reliability of electrically conductive interconnections was assessed by utilizing two accelerated lifetime tests: temperature cycling test (-40°C...+125°C with 142 min cycling period) and steady state humidity bias test (85°C/85RH%). The long-term performance of test samples was monitored with electrical measurements (2-point 100 mA constant current feed and 4-point resistance measurement) to indicate the interconnection malfunction.

After conducting the tests, the measurement data was examined with Weibull analysis, when applicable, resulting in a cumulative failure rate over time for each 10 sample test population.



assembling conductors.

Figure 1. Automated roll-to-roll pickand-place machine Datacon 2200 EVO assemble



Figure 2. Flexible connectors assembled on OLED foil with conductive adhesive interconnections.



Figure 3. Failure mechanism at the interconnection area in 85°C/85RH% test

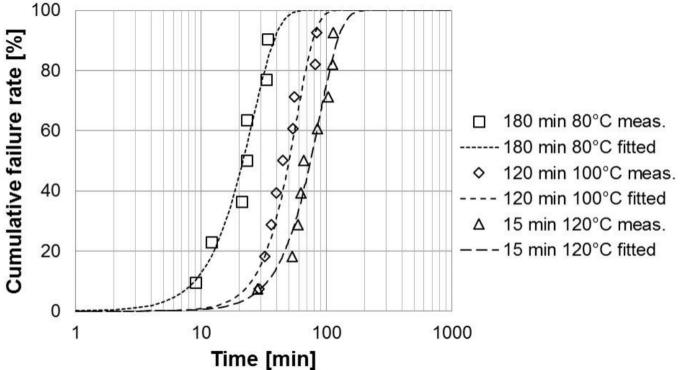


Figure 4. Weibull cumulative distribution functions for test populations in 85°C/85RH% test

## Results

The manufactured test samples showed good reliability in temperature cycling tests as only occasional samples out of the three studied test populations failed during 800 cycles. On the other hand, the test structures turned out to be vulnerable to the high temperature and high humidity condition. The evaporated silver layer contacts on the OLED foil were peeling off due to moisture and thus degrading totally the electrical interconnection (Figure 3). Based on the recorded measurement data and Weibull analysis, cumulative failure rates for the studied populations in 85°C/85RH% test were calculated as presented in Figure 4.

In addition, curing conditions were noticed to have an effect on the measured nominal resistances of the test samples. Higher curing temperatures resulted in lower resistances at the interconnections.

# Conclusions

This study showed the capability to interconnect flexible conductors on a flexible OLED foil by utilizing an automated pick-and-place machine and electrically conductive adhesive. From the studied curing conditions, 15 min at 120°C proved the best performance from both conductivity and reliability point of views. However, the interconnection areas were found to be vulnerable for moisture and that fact should be taken into considerations in further assemblies.

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The project PI-SCALE has received funding from the European Union's Horizon 2020 research and innovation programme under Grant Agreement No. 688093.



