A Micromachined Printhead for the Evaporative Printing of Organic Materials at Ambient Pressure

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Organic optoelectronic devices are promising for many commercial applications if methods for fabricating them on large-area, low-cost substrates become available. Our project investigates the use of MEMS in the direct patterning of materials needed for such devices. By depositing the materials directly from the gas phase, without the liquid phase coming in contact with the substrate, we aim at avoiding the limitations due to inkjet printing of such materials.

We developed a MEMS-enabled technique for evaporative printing of organic materials. This technique does not require a vacuum ambient, has a fast printing rate (1 kHz), and can be scaled up to an array of individually addressable nozzles. The MEMS printhead comports a microporous layer with integrated heaters for local evaporation of the materials. Figure 1 shows the microfabricated device: an array of 2 micron pores and an integrated thin film platinum heater sit in the center of a silicon membrane. The material to be printed is delivered to the porous region in liquid or gas phase and deposits inside the pores (see Figure 1, top left). The integrated heater then heats up the porous area (see Figure 2, top) and the material is re-evaporated from the pores onto the substrate. The main limitation of this printhead is the failure of the thin-film platinum heater at temperatures above 800°C (see Figure 2 bottom).

This printhead was used, together with inkjet technology for the delivery of material to the pores, to print molecular organic semiconductors (see other abstract in this volume). Our technique enables printing of organic optoelectronics over large areas and can be used to print on a variety of substrates, does not require a vacuum ambient, and thus could enable low-cost printing of optoelectronics.

Figure 1: Left: Pictures of the pores. Top: Fluorescent image after Alq3 material was loaded in the pores. Bottom: Optical image after re-evaporation of the material. Right: Top view and schematic of device.

Figure 2: Top: Infrared microscope measurements of the temperature of a printhead chip. Bottom: An SEM image of a Focused Ion Beam cross-section of a failed heater.

REFERENCES