INKJET NEWS

Printed Electronics

One of the ultimate goals in electronics is the ability to directly write electronic components and circuits. Advancing materials chemistry and developing printhead technology is bringing this goal closer to reality.

Print Technology: Drop on demand printing deploys the piezo electric effect of inkjet technology to deliver precise and consistent quantities of fluids. Typically, current printheads are designed with 128 nozzles on a single printhead. Each nozzle is able to independently deliver fluid at a frequency of up to 20,000 drops per second. Such a printhead would have a natural resolution of the order of 50 dpi and therefore grouped in an offset bank of 8 heads can generate a 400dpi resolution. Multiple print passes allow higher resolutions.

Printing onto absorbent surfaces such as paper, where the substrate acts as a brake to fluid flow is relatively straightforward. PTL's patent protected know-how of fixing the image on less friendly surfaces is an important factor in achieving the desired end product.

What does this mean in practical terms? Although dependent on the print fluid and print surface characteristics, the above design at 400 dpi resolution would enable feature sizes in the region of 100 micron track and gap, without further post printing treatment. The printing time for a 600mm x 800mm substrate would be of the order of 1 minute.

Digital inkjet printing is a binary process. The image to be printed is broken down in to a matrix of squares with an on-off print signal to the nozzle. Therefore printing diagonal lines can suffer the potential of a saw tooth effect which is seen as a challenge for some applications. Introduction of 'grey scale' in the soon to be released new generation printhead (a process where the printer fills in the saw tooth steps) reduces this problem significantly.

In addition to 'greyscale' these new printheads will deliver smaller drop volumes allowing smaller feature sizes which are expected to be in the region of 50 micron track and gap. Although this may not be the limit of printhead design, it does mean that without post print treatment these feature sizes limit the direct write capability. For example, in the displays sector screen sizes of 42" and above.

Finer feature definition either requires pre-treatment of the substrate surface to influence the flow of material on contact with the surface or post print ablation with laser or other techniques. There are ongoing novel technological developments in all these areas.

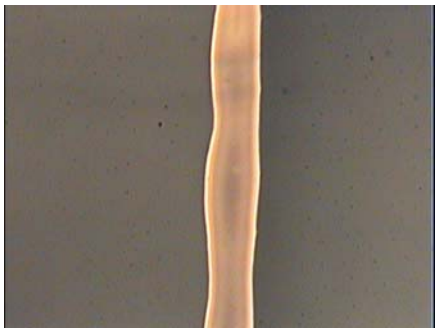
Having fixed the image on the surface, it is crucial to be able to control the pattern with a reliable and consistent delivery system. This is the domain of the print platform and the integration in harmony of mechanical design and digital programming. PTL works closely with machine manufacturers to bring together fluid and printhead technology, together with the total manufacturing process to produce an industrial scale integrated solution.

Print Fluid Formulation: Print fluids can be solutions or suspensions provided the particle size is within the printhead capability. Many iterations are generally required to produce a fluid that has the correct performance characteristics to 'jet' from the printhead and yet also interact with the substrate in the desired manner and furthermore withstand the final processing and performance conditions for which they are destined.

With its fluid supplier partners, PTL has successfully formulated a range of fluids for a number of applications. It has a tried and tested formulation for etch resist, hardcoating, legend printing and carbon. The etch resist has been some years in development and has been successfully demonstrated in photo-chemical etch process applications for a number of clients. Direct writing of the patterned etchmask eliminates costly steps in the photolithography process. This is a pre-cursor of course to the ability to directly write the patterned end product.

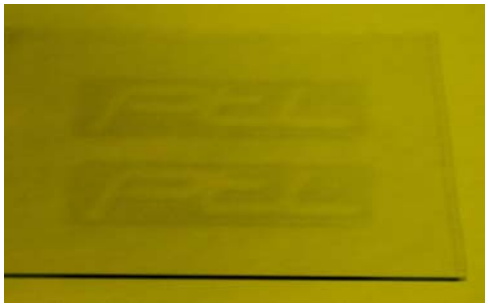
In this regard. PTL is also in the advance development stages of transparent conductors and metallic silver and gold. Its work with the transparent conductor has generated much interest in the displays and electronics industry, and since its first publication in Materials World June 2001, PTL has made continued to develop its capability. PTL has achieved 200 ohms/sq with transparencies of 75% and has demonstrated direct write patterning of the transparent conductor. With one development client a working display device using its printed conductor has been produced. PTL has plans to

develop this work further including printing on plastic substrates and laser annealing.



Printing of Gold on Glass

Following closely behind the transparent conductor is success in printing of metallic conductors. A key advantage of drop on demand printing over other processes is the access it provides to higher performance and usually higher cost materials may be used effectively. Because the fluid is deposited only where it is required, drop on demand means little or no waste and higher value materials become economically viable. PTL has achieved feature sizes of 100 micron and conductivities of 50% and 75% of the bulk properties for silver and gold respectively. Post print metallization is still required and at present temperatures of 400 deg C are required and development work with the formulator to bring this down to 150 deg C is targeted.



Direct Write Patterning of Transparent Conductor on Glass

Process Integration –the Real Benefits: The consequences are significant in so far that the traditional photo-lithographical processes are turned on their head and simplified. Direct write patterning removes the need for photo-tools, expensive coating, exposure and develop/wash process equipment. With direct write, etch and strip are also removed. The capital cost of printers is significantly less and the reduced space requirements has the added benefit of reducing clean room areas and hence facility costs. There are also environmental benefits by reducing waste treatment requirements.

As data are digitally stored there is the added operational flexibility of being able to make last minute changes, process multiple jobs and of particular interest to the displays industry, with camera detection the ability to re-work jobs in-line increasing yields.

Future Development: PTL's intellectual property includes patents covering the printing of passive and active devices such as resistors, capacitors and transistors. Applications for Government grants for the development of this technology is in hand and commercial processes are in place to work with its formulators to develop inorganic active components. PTL's believes the short to medium term will be driven by the higher performance of inorganic materials. There is clearly a future for organic devices as evidenced by PTL's patent portfolio, and there is a lot of active research and development in this area. However, PTL considers that his will be over a longer time horizon.
As part of its ongoing development plans, PTL is also investigating new and interesting formulations applicable both within and outside of the electronics and displays arena. PDP and LCD still compete for a place in the market, but print technology is applicable to both. In addition to the direct writing of devices, inkjet printing is seen to offer lower cost and operationally more flexible solutions to printing alignment layers, conductors and colour filters. In the case of PDP, inkjet printing's ability to create 3D micro-structures has its use in printing of the wells in addition and also the phosphors.

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