STRETCHING CREDIBILITY?

Despite the incredible potential of thin-film inkjet printheads, this development could be a case of the Emperor's new clothes, opines Richard Darling

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Thin-film MEMS technology applied to industrial inkjet sounds super exciting, but in reality, it doesn't easily make commercial sense.

MEMS as an acronym stands for 'micro electro-mechanical systems'. All inkjet printheads are MEMS by definition. The specifics here are silicon manufacture and the deposition of a thin film of piezo-electric material, in place of machined, relatively large chunks of PZT. So, the topic here is SiMEMS.

SiMEMS structures are made from silicon, a semi-conductor material, which is produced with anisotropic etches and oxide barrier layers. This technology enables reproduction of detailed, tiny structures with otherwise unseen repeatability which in turn promises significant printing performance advantages seen as superior to bulk piezo inkjet. This is why technology experts believe it is the future.

However, it is a very expensive process that requires FAB labs [digital fabrication laboratories] to produce. These labs cost on average $1 billion to make, so unsurprisingly there are under 200 worldwide to cover manufacturing of all products that involve this technology, including printheads, but mostly consumer electronics.

With available FAB supply, and the particulars of inkjet printhead demand, plus tooling needed, it is very costly to make thin-film printheads particularly compared to bulk piezo.

WHAT ARE THE BENEFITS OF THIN-FILM?

Thin-film inkjet is attractive for many that are convinced that single-pass printing in multiple industries is the future. Single-pass inkjet printing enables faster speed which is often regarded as a required characteristic of industrial production.

But this is in itself a debatable point as in fact Richard Darling, amongst others, elaborated in his talk at the FuturePrint Virtual Summit [held from 12–16 October 2020].

Thin-film MEMs Inkjet heads are clever and compelling of course – they enable higher nozzle counts, tighter packing densities and smaller drop sizes all regarded as critical for effective single-pass printing and some would say industrial, analogue-equivalent print quality.

Thin film promises uniform precision manufacturing with high yield, small and highly complex optimised structures to deliver fluids with even pressure distribution and highly controlled jetting performance at previously unseen firing frequencies.

These are all the nerdy things but the benefits these deliver can include high-resolution print, highly defined imaging enabling small text in superb quality with photo-imaging and tonal gradients that have only so far been achieved by offset printing, and at break-neck speeds.

This is an exciting technical development for the inkjet industry. High speed inkjet printing and at the right image quality as well. Traditional 'Print snobs' might even be impressed. Suddenly, the previously impenetrable markets that offset and flexo have commanded and dominated may now be open to seduction by the charms of thin-film inkjet. And cost per nozzle can be lower – provided fixed costs and R&D expense is spread over a very large volume of production.

The significant downside of this exciting technology is the indisputable fact that cost attached to manufacture of SiMEMS printheads is huge unless volume of production is even more huge.

DO THE MATHS

Does thin-film inkjet solve a problem so large that it can justify this gargantuan investment in production? And does the commercial argument for thin-film inkjet really stack up?

From initial research and anecdotal observation, for me it's difficult to escape the maths. Perhaps for some, excited by the technical possibilities, this is not something that is front of mind in those who may be commercially, technically or perhaps emotionally invested in the technology.

If a printhead manufacturer spends $250m to develop thin-film capability and a SiMEMS printhead, and then sells 250,000 of these printheads over a period of time, then R&D expense alone would need an allocation of $1,000 per printhead. This figure overlooks the financing costs on such an investment for the period from spending to payback which may be five, 10 or more years. We could, though we should not, put aside the opportunity cost and significant risk factors, both technical and commercial. Thin-film inkjet is a big, expensive and risky venture. There have been reports of some players accounting for much, much greater spend than $250m in this quest.

To expect sufficient traction such that industrial market demand tops 250,000 units within a reasonable payback period is ambitious. New performance possibilities are always accompanied by emergence of new challenges: integration into useful equipment forms with the requisite reliability and cost of ownership is not easy. Ultimately, markets and customers need to be sufficiently convinced and confident in order to invest and adopt.

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Demand volume in my simple maths also assumes no interference from competitors who have similar ideas and ambitions, i.e. no producer can expect to monopolise. However, any possibility for sharing of overall demand volume could be crucial to the printhead producer.

WHAT IS WRONG WITH BULK PIEZO?

Not that much, as I see it. Tried and tested technologies are very good. I am an innovation evangelist, but I see no sense in innovation for the sake of it.

Everyone wants a lower cost. In reality, a printhead is an imaging 'paintbrush'. A print swathe has a hardware cost. Per inch of swathe, a 1200dpi printhead has more nozzles (double that of a 600dpi printhead) so even if the nozzle cost of a 1200dpi SiMEMS is half that of a 600dpi bulk piezo device, the print swathe capability costs the same.

Firing tiny drops at high frequencies is more problematic; risk of nozzles failing to fire increases. Commonly, SiMEMS operation needs to provide nozzle redundancy and error correction for most single-pass processes. Necessarily some nozzles are therefore not fully utilised but are held back as error correction back-up. Is this compromising reliability for cost-effectiveness or cost-effectiveness for reliability?

Either way, it's a trade-off.

Nothing new is perfect, and with thin film, this is also the case. Progress in adoption of this exciting technology therefore hasn't been fast. My view is that bulk piezo inkjet should not be quaking in its boots just yet. Sure, thin-film is exciting and very clever. But before the Emperor begins parading his new virtual clothes, there are plenty of solvable problems to be very effectively addressed with current reality, bulk piezo inkjet. Maybe taking an expensive gamble is unnecessary, particularly so during this period of such uncertainty.

AN UNCERTAIN PATH

It is also possible that this technology is travelling through a hype cycle, that it has already transcended the peak of inflated expectations and is now descending into the trough of despair. I am not suggesting that this innovation is doomed to fall into the chasm, never to cross and find its place, but it may take some time for it to find its place and gain the necessary traction that will make it a

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mainstream choice and economically viable for producers as well as users. Thin-film may yet find its particular purpose and it may well yet ascend the slope of enlightenment. However, one might think right now given the commercial pressures placed upon industries and markets, this could well be some way off.

Allocation of R&D dollars and the talk track of technology experts expects us to believe in SiMEMS. It would be useful to debate this in full to understand whether the Emperor is either naked or dressed in very fine new materials. A longer-form paper discussing this topic in greater detail is available on request from richard.darling@ricoh-europe.com or marcus.timson@fmfuturenow.com. ■

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