ULTRA-HIGH VISCOSITY – REWRITING THE RULE BOOK

Xaar's Angus Condie, John Tatum and Renzo Trip discuss the increased printing speed, resolution and reliability of a new generation of digital inkjet printheads and how they enable higher viscosity

Angus Condie is Director of Technology at Xaar

John Tatum is Principal Scientist (Inks and Materials)

Renzo Trip is Principal Engineer (Advanced Applications and Technology) at Xaar

The key limitation of inkjet printing has been the fluid properties of the jetted ink. Traditionally, inkjet has only been capable of using low-viscosity fluids with low solids loading. The formulation of all existing inkjet fluids are constrained by the fluid capabilities of the printheads. This has imposed restrictions on the printing process, the properties and functionality of the deposited fluid, resulting in the range of applications where inkjet has been deployed.

THE CHANGING RULES

Over the last 30 years, Xaar has been driving industrial inkjet innovation. More recently, Xaar's technology platform ImagineX is changing the rules for ink formulation, enabling jetting of fluids with significantly higher viscosity – up to 100cP at jetting temperature – and much higher pigment loading. Furthermore, with the ability to print at elevated temparatures, printing fluids, with viscosities at room temperatures, of over 1,000cP, is now possible.

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This high-viscosity capability – available across a range of Xaar's printheads – radically releases the constraints of fluid formulation. Chemists can now select from a much larger cupboard of ingredients, providing options to target cheaper inks or those with higher functionality. Fluids can now be developed to both improve the performance of existing printing applications, as well as opening a world of new ones. Developers and ink technologists can create faster-curing UV inks that require much less energy to cure. In addition, it is possible to use inks with very low migration into the substrate. Improved toughness, scratch resistance, flexibility and adhesion are all available because of the much more complex chemistry being jetted.

Sustainability can be enhanced on many levels – from UV inks requiring less curing energy to higher pigment-loaded fluids requiring fewer print passes – and therefore lower consumables. Aqueous inks, containing high-pigment loading and a lower ratio of water, can significantly reduce drying energy and transport costs.

Having the capability to handle fluids at viscosities of up to 100cP at jetting temperature is increasing the relevance and practicality of inkjet technology across a variety of new printing, coating, advanced (functional fluids) and additive manufacturing applications.

Inkjet is rapidly becoming the technology of choice for additive manufacturing and 3-D printing. It is also becoming popular for personalisation, coating and other innovative print and manufacturing processes. Higher viscosity capability enables digital jetting of fluids not previously possible, such as adhesives, paints and photo-resists. This

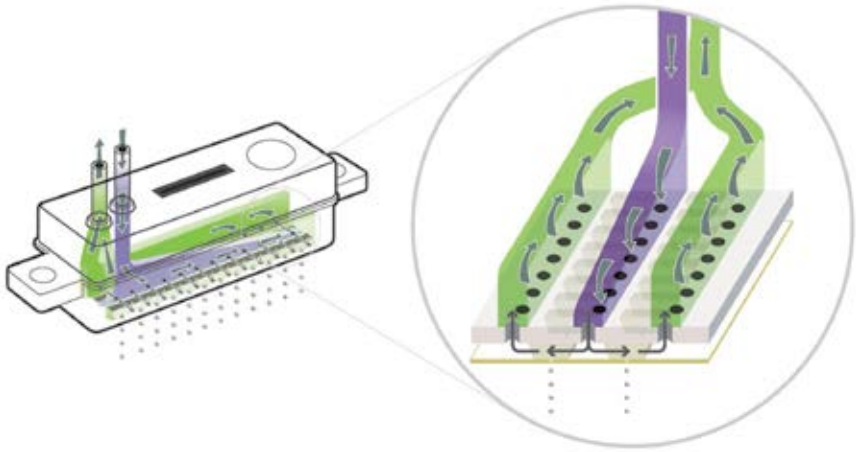

Figure 1: The fluid flow through Xaar's hydrid side-shooter architecture. Purple indicates the incoming fluid and green the outgoing fluid on either side of the nozzle

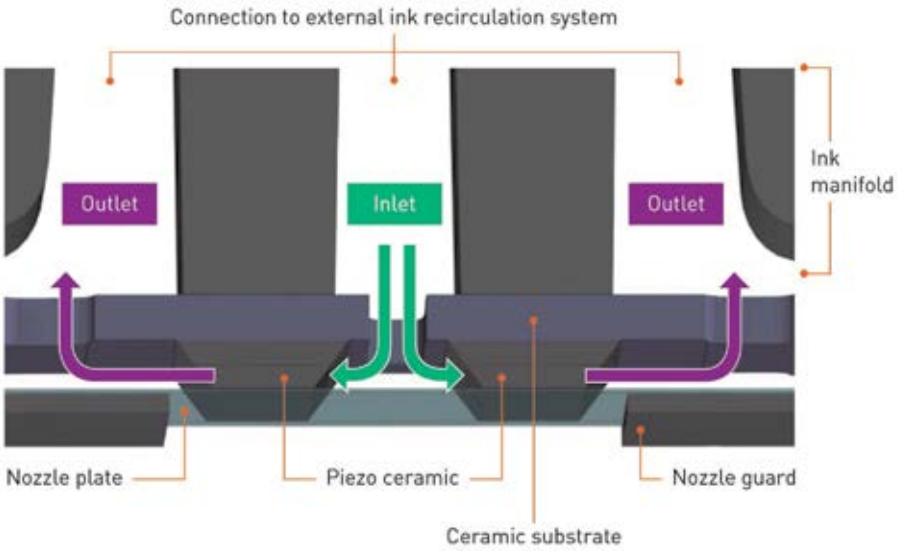

Figure 2: Schematic of Xaar's TF technology showing the path of fluid entering and exiting the piezo-ceramic channels directly behind the nozzles

opens up newer applications for digital inkjet, including bio-medical, automotive, printed circuits, electronics applications and braille printing.

ENHANCING TODAY'S APPLICATIONS

TF technology has enabled the use of inkjet in the industrial ceramics and glass decoration markets using highly particle-loaded inks. Increased viscosity improves particle stabilisation, as well as increased particle concentrations, densities and fluids. This benefit can be applied to oil-based, UV, solvent and aqueous inks with broad-reaching advantages for many applications. For example, yielding a wider colour gamut and greater opacity in single-pass printing, offering the capability to reduce ink thickness and energy savings with reduced UV curing or drying of aqueous inks. This unprecedented capability delivers benefits in many applications. Xaar's new printhead – Aquinox – is a good example, for labelling, packaging, direct-to-shape, direct-to-garment and textile applications using water-based inks.

HOW DO XAAR PRINTHEADS ENABLE HIGH VISCOSITY?

Xaar's TF technology continuously recirculates the ink through the complete fluid path. The ink immediately passing the back of the nozzle and within the nozzle itself is a very important part of this process. Xaar's printhead architecture, with its simple, short and low-resistance fluid path, also creates recirculation at very high flow rates. This constant movement removes debris and bubbles from the actuator, improving jetting reliability and enables nozzles to 'self-recover' from blockages. TF Technology is also instrumental in keeping particles in suspension for highly loaded inks.

Not only does TF technology allow for the reliable printing of high-viscosity inks, it also facilitates another of Xaar's advances – high lay down technology.

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In addition, use of previously non-jettable, single-pass fluids presents an opportunity to deliver new and exciting finishes for clients across a much wider variety of packaging materials. Amongst other possibilities, high-build varnish embellishments can be applied more easily adding texture, visual impact and functionality. Even printing direct to the primary packaging or product itself can be achieved. These new technologies can produce a range of additional capabilities, from braille and tactile warning triangles on labels, to the latest haptic and embossed effects. Jetting higher-viscosity fluids also offers improved edge definition on non-porous substrates, due to reduced drop spread – dot gain in analogue printing – before the print is fixed.

High lay down technology introduces a print mode to existing printheads which delivers larger, binary-printed drops at high printing frequencies. This produces a massive increase in throughput for high volume/productivity applications. Xaar's printhead architecture means that, as well as being able to print high viscosity in conventional grey-scale printing modes, high-viscosity fluids can also be printed in high productivity high lay down mode with no significant difference in performance.

The recirculation within the nozzle also plays a role in increasing latitude for ink formulation because it significantly improves nozzle open time. By ensuring continuous replenishment of the ink in the nozzle and keeping the meniscus active, Xaar's TF technology printheads show nozzle open times of typically higher magnitudes. This makes digital inkjet suitably reliable for new applications, as well as providing ink chemists with yet more flexibility by reducing humectant levels.

A WORLD OF NEW APPLICATIONS

Access to more raw chemical ingredients, greater flexibility in fluid formulation and access to new functional group chemistries and new base solvents unlocks ever-wider uses for digital-inkjet printing. In addition, higher pigment loading, via better suspension stability, becomes possible.

Completely unexplored markets for inkjet technology are now accessible, with everything from adhesives to printed electronics and paints potentially benefiting. All these new opportunities are available through the capabilities driven by Xaar's range of technologies.

In chemistry, access to new formulations and new optical, mechanical and other functional properties for printed parts and new applications have become available. In design and manufacturing applications, a revolution in design is underway, enabled by the use of inkjet in additive manufacturing.

CONCLUSION

With sustainability at the forefront of these technological developments, inkjet also minimises material waste through the highly precise jetting of fluids and inks across all applications. A switch from analogue to digital often results in a significant reduction in the amount of fluid used, as well as the time and energy used to pre-treat or prepare surfaces.

Xaar's services and products allow customers and partners to access digital inkjet expertise and equipment as a technology parallel to the development of fluids and applications. Ultimately time-to-market is reduced and stakeholders are provided with a high level of confidence in inkjet. This is thanks to the increasing possibilities and opportunities opened up with ultra-high viscosity technology. ■

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Further information:
Xaar, Cambridge, UK
tel: +44 1223 423663
email: info@xaar.com
web: www.xaar.com