

EXPANDING INKJET'S CAPABILITIES WITH ULTRA HIGH-VISCOSITY TECHNOLOGY

Neil Cook, at Xaar, reports on the impact that ultra high-viscosity inkjet technology is having on the future of digital manufacturing



Neil Cook, Head of Strategic Marketing, Xaar



Xaar's range of High Viscosity capable printheads 50x, 2002, Nitrox and Aquinox. Covering UV, oil and water-based fluid jetting

Inkjet printing has evolved significantly from a graphics technology into a highly capable industrial deposition method. Its digital nature, high resolution and process flexibility have allowed adoption across many markets. Historically, however, the fluids suitable for jetting were constrained by viscosity. Most industrial printheads were limited to fluids in the region of 5–12cP at jetting temperature. This restricted particle loading, limited colour strength and constrained the range of functional materials that could be deposited. Xaar's ultra high-viscosity (UHV) technology has now removed this limitation by enabling jetting of fluids up to 100cP at jetting temperature which could mean over 1,000cP at room temperature. This capability is expanding inkjet's role in printing, coating and additive manufacturing. Additionally, it is enabling formulation strategies that were previously incompatible with digital deposition.

VISCOSITY AND ITS IMPACT ON JETTING

The viscosity of any ink is influenced by temperature, the base material and the concentration and type of particles within it. These principles have long created barriers for inkjet, since particle-rich or polymer-rich materials tend to have significantly higher viscosity at the temperatures used in conventional printhead systems.

Conventional industrial inkjet systems

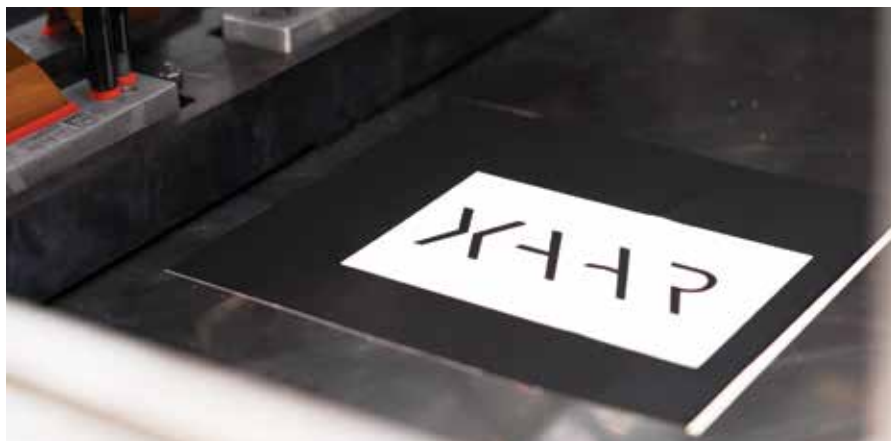
required heating of UV-curable fluids to around 45C° in order to lower viscosity sufficiently for jetting. Xaar's UHV technology reduces the need for such heating because the printheads are able to deliver reliable jetting at higher viscosity values. This reduces energy demand and broadens the type of materials that can be deposited.

"Drying times are shortened and fewer passes are required"

INDEPENDENT VALIDATION

Swansea University's Welsh Centre for Printing and Coating has independently assessed Xaar's UHV capabilities using

Nazdar's high-viscosity aqueous inks with the Xaar Aquinox printhead. The study demonstrated a 67% increase in colour density on coated white corrugated substrates, compared with conventional viscosity inks. Because higher-viscosity inks penetrate the substrate less, the same colour intensity can be achieved with significantly reduced ink volume. This reduction in ink lay down directly decreases drying time and energy consumption. The research also demonstrated that high-viscosity inks with high pigment concentrations maintain the same pigment-to-binder ratio as their low viscosity equivalents, ensuring a controlled and fair evaluation.



Ultra high viscosity enables higher pigment loading resulting in more opaque whites

TECHNICAL FOUNDATIONS OF UHV JETTING

Xaar's ability to jet high-viscosity fluids is supported by the unique printhead architecture and technologies. Central to this is transport format (TF) technology, which continuously recirculates inks and fluids at high flow rates directly behind the nozzle. This flow removes debris and air bubbles from the actuator and ensures that fluid temperature remains consistent across the printhead. High-viscosity fluids are particularly sensitive to temperature variation because they often operate on steeper viscosity-temperature curves. A small temperature fluctuation can cause significant viscosity changes, which makes uniform recirculation and thermal stability essential. Xaar's TF technology is also used to refill the fluid channel after a droplet has been ejected. This means that the task of drawing high-viscosity fluid into a thin narrow channel is handled by a fluidic pump rather than the low powered piezo-electric actuator.

In addition, high lay down technology further enhances the productivity of UHV jetting. By using a modified jetting mode, drop volumes can be increased while maintaining high firing frequencies. Xaar has demonstrated ejection rates of over 300ml/min with existing printheads, allowing very high throughput for coatings and textured applications.

"UHV technology contributes significantly to sustainability goals"

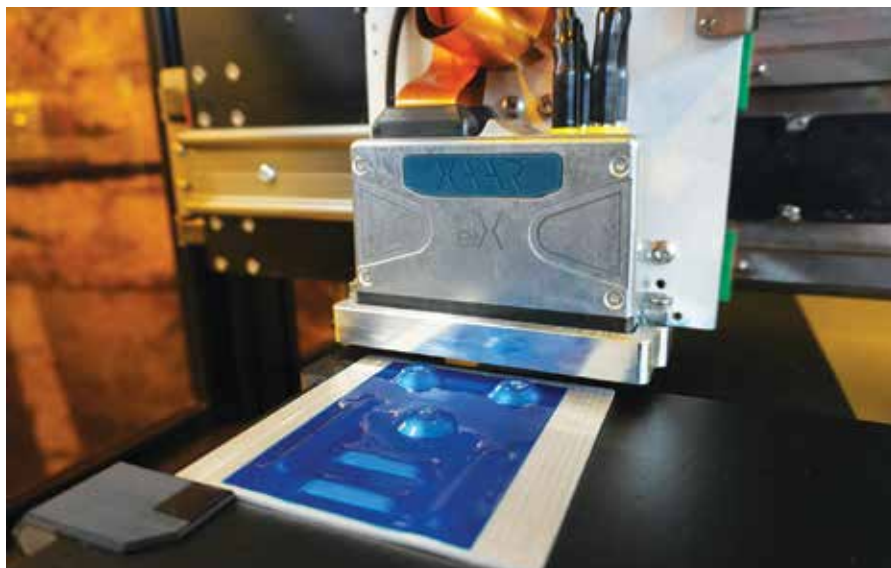
QUALITY AND PERFORMANCE

Higher viscosity fluids deliver several measurable improvements in print performance. Reduced penetration into porous substrates allows sharper edges and better definition. This is visible in small text, barcodes and fine details, where reduced spreading directly improves scanning accuracy and readability. Increased particle concentration produces stronger blacks and more opaque whites, with high opacity achievable in a single pass. These characteristics are essential for direct-to-shape packaging, labels, glass decoration and applications requiring strong visual impact.

Since high-viscosity inks require less volume to achieve a given optical density, drying times are shortened and fewer passes are required. This results in higher productivity and lower overall energy usage.

EXPANDING APPLICATIONS

The ability to jet highly viscous functional fluids is driving inkjet adoption in fields that previously relied on analogue, spray or contact deposition systems. Examples include jetting of adhesives, conductive materials, dielectric materials and photo-resists. All of these often possess high viscosity at operating temperatures.



High Viscosity is essential for coat uniformity of EV battery protective layers

In automotive manufacturing, the ability to digitally deposit high-viscosity paints, supports precision two-tone coating without masking and with reduced overspray. This digital approach can contribute to CO₂ reductions of around 30% in certain applications because deposition is localised rather than sprayed. In the battery energy sector, high-viscosity dielectric materials – used for EV battery and solar cell manufacturing – can be jetted with accuracy and scalability. Reduced ink penetration and improved colour strength also benefit sectors – such as textiles – with brighter and more durable printing.

Perhaps the most transformative area is additive manufacturing. Jetting polymers with higher molecular weight provides enhanced mechanical properties such as strength, elasticity and resilience. These materials expand the range of functional and load-bearing geometries achievable with inkjet-based 3D printing.

The capability is also driving innovation in existing inkjet print markets from the jetting of frits and glazes in ceramics to high-build varnish embellishments and braille printing onto packaging, labels or the product itself. The greater colour vibrancy and stronger, higher opacity black and whites, as well as better-defined edges available from jetting highly viscous inks and fluids is driving change.

"UHV technology represents a substantial shift in inkjet's industrial capability"

UHV EFFICIENCY

Since high-viscosity inks achieve required colour density with lower ink volume, material consumption is reduced. Therefore, UHV technology contributes significantly to sustainability goals. Lower absorption into substrates means less water is introduced into the drying stage, thus reducing the energy required for evaporation. Eliminating

primers in corrugated and other packaging workflows further decreases chemical usage, cost and process complexity.

CONCLUSION

UHV technology represents a substantial shift in inkjet's industrial capability. By enabling jetting of fluids that were previously incompatible with digital deposition, it has opened new opportunities for printing, coating and additive manufacturing. Independent research confirms significant gains in colour density, material efficiency and energy reduction. At the same time, unique capabilities such as TF technology, sure flow and high lay down have created a stable platform for high-viscosity jetting. Industries continue to prioritise sustainability, precision and process flexibility and UHV technology is now playing a central role in the next generation of digital manufacturing. ■

Neil Cook is Head of Strategic Marketing at Xaar



High viscosity fluids enable the use of new and alternative chemistries increasing the functionality of the fluids

Further information:

Xaar, Cambridge, UK
tel: +44 783 477 6643
email: neil.cook@xaar.com
web: www.xaar.com