WHITEPAPER

Trajan Pure-Pass GLC well plates

Quality manufacturing: How surface chemistry, design & control drive high performance

Introduction

Advances in mass spectrometry (MS) continue to push the boundaries of analytical sensitivity, enabling the detection of more target analytes at increasingly low concentrations. Yet the MS instrument is not the starting point of the sample journey. What is frequently overlooked – and what can silently undermine the most sophisticated analytical method – is the quality of the container in which the sample is prepared, stored, and presented for analysis.

Glass has long been the material of choice for individual vial analysis, offering the chemical inertness and surface neutrality that demanding applications require. However, the transition to high-throughput, automated workflows has favoured polypropylene well plates – valued for their ease of automation handling, compact design, and low cost. The consequence is a compromise: workflows gain throughput but lose the surface performance that glass provides.

Trajan's GLC (glass-like coating) technology directly addresses this compromise. By applying an inert, silicon-oxygen (Si/O) coating to a polypropylene well plate, Trajan delivers glass-comparable surface performance within the standard ANSI/SLAS microplate format – without the handling complexity, set-up time, or automation limitations associated with glass inserts or vials.

The challenge: Sample loss and automation constraints

Non-specific binding and analyte adsorption

Non-specific binding (NSB) is the phenomenon by which target analytes adsorb to the surface of their sample storage container impacting accuracy and reproducibility. NSB occurs through a combination of hydrophobic and hydrophilic interactions between the analyte and the container surface, and can impact analysis of:

- Hydrophobic or lipophilic small molecules
- High logP analytes
- Peptides and proteins prone to surface adsorption
- Low-concentration samples
- Samples requiring extended storage prior to analysis

The consequence of NSB is a reduction in analyte signal that can manifest immediately or develop gradually over time. The result can be lower extraction efficiencies, inaccurate

quantification, failed method validation, and irreproducible results — problems that become particularly acute in regulated analytical environments such as bioanalytical quantification, clinical monitoring, and pharmaceutical quality control.

Limitations of existing solutions

Laboratories facing NSB challenges have historically had limited options. Standard glass vials offer inert surfaces but do not conform to the ANSI/SLAS well plate format required by most automated liquid handling systems. Other glass alternatives - such as glass inserts seated inside glass vials or plates - introduce additional complexity: longer set-up times, manual adjustment of automation parameters, ongoing monitoring that limits overnight or unattended runs, reducing throughput. High-quality polypropylene plates improve upon commodity polypropylene in terms of purity and extractables but do not fundamentally alter the surface chemistry responsible for NSB.

GLC technology: glass-like performance in a well plate format

Surface chemistry

Trajan's GLC coating is a surface treatment comprising silicon (Si) and oxygen (O) as major components — the fundamental building blocks of borosilicate glass. Applied to the inner surface of the well, the coating creates a glass-like interface that replicates the chemical neutrality of glass without altering the footprint of the polypropylene microplate compatible with automated systems.

The GLC surface provides:

- Alternative surface where polypropylene is not suitable for sample handling due to loss of analyte
- Surface performance comparable to a glass vial in a high-density format
- Ultra-clean well surfaces with additional protection against polymer contaminants suitable for trace-level and low-volume analysis

Analyte recovery performance

The performance of the GLC surface is demonstrated through changes in analyte recovery amongst different sample containers.

In comparative studies assessing recovery of analytes (Figure 1), Pure-Pass GLC well plates exhibit similar or better analyte recoveries than glass vials. Both glass-like and glass surfaces exhibit improved recoveries relative to polypropylene for all but the most polar analytes studied. Pure-Pass GLC plates show excellent recovery performance even over an extended analysis window (i.e. 16-hour sequences representative of overnight unattended instrument operation). This temporal stability is essential for laboratories running large sample batches or extended sequences without manual intervention.

Sample recovery and variability with Pure-Pass GLC plates vs other containers

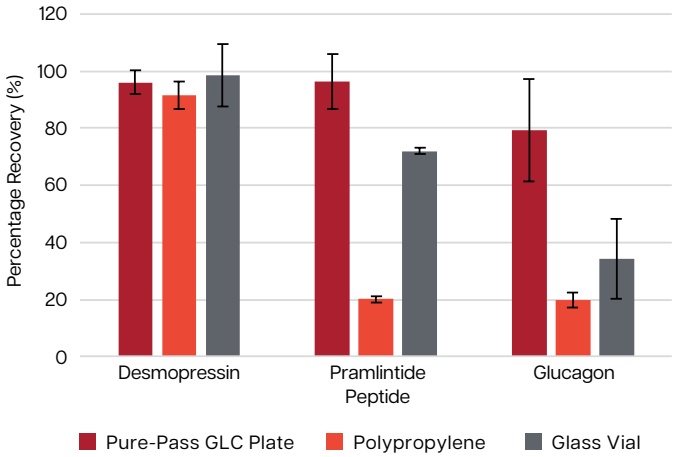


Figure 1: Pure-Pass GLC plates demonstrated the highest sample recoveries after 16 hours of storage at 6°C for 20 ng/mL peptide samples, outperforming both glass vials and polypropylene plates. Recovery was assessed by calculating the percentage of analyte remaining at 16 hours relative to the initial concentration at 0 hours.

Reconstitution following extraction is another critical sample preparation step in many analytical workflows where variation in recoveries can significantly affect results of the analysis. In a study of recoveries of target small molecules (drugs at concentrations of 1 ng/mL) following sample reconstitution the Pure-Pass GLC well plates allowed reconstitution to higher concentrations than pure polypropylene plates and offers

performance comparable to glass vial inserts while maintaining the sample handling consistency of a polypropylene format (Figure 2).

Small-molecule drug recovery following sample reconstitution in Pure-Pass GLC plates versus alternative containers.

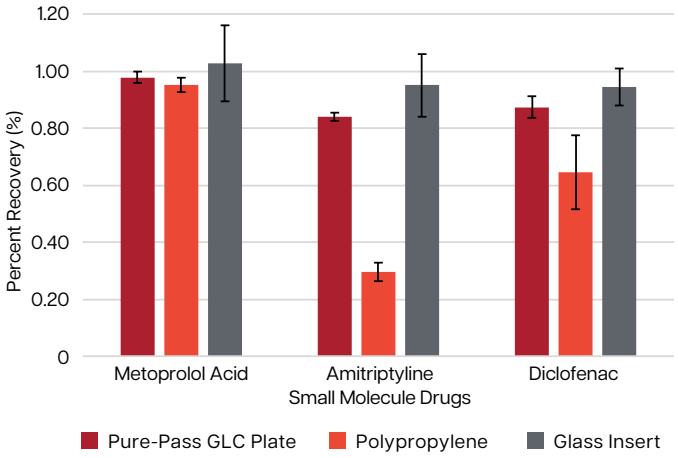


Figure 2: Sample recovery of 1 ng/mL small molecule drugs in Pure-Pass GLC plates is comparable to glass inserts and significantly better than polypropylene plates following reconstitution. 300 µL of sample containing target small molecules were added to a sample container, dried down and reconstituted with the addition of deuterated internal standards (ISTD) before analysis. Percentage recovery was calculated by dividing the concentration of the reconstituted target analytes by the concentration of the spiked-in deuterated ISTD.

Automation integration

Pure-Pass GLC well plates conform strictly to the ANSI/SLAS microplate format standard, with dimensional tolerances designed to ensure reliable integration with automated liquid handling equipment. Unlike glass insert solutions – which require instrument reconfiguration, extended set-up times, and ongoing monitoring that limits overnight or unattended runs – Pure-Pass GLC plates are a drop-in replacement for standard polypropylene plates within existing automated workflows.

The result is a measurable improvement in laboratory throughput: fewer interruptions and failed runs, less instrument downtime, fewer re-runs and manual interventions, and greater sample capacity through more reliable unattended operation – all while delivering the surface performance required for demanding analytical applications.

Manufacturing quality and process control

Raw material selection

The Pure-Pass GLC well plate manufacturing process begins with the selection of ultra-high purity polypropylene. The choice of polypropylene grade is not incidental: chemical purity of the base material is directly critical to two distinct quality outcomes:

- **Coating adhesion** – the glass-like coating bonds to the polypropylene substrate, and the presence of processing aids, additives, or impurities in lower-grade PP compromises adhesion uniformity and long-term coating integrity
- **Extractables and leachables** – impurities in the base polymer must be kept to a minimum, as they can migrate into the sample, introducing matrix effects and contaminants that undermine reliability of results

Trajan's specifications require polypropylene that meets the highest purity standards for this application, ensuring a clean substrate baseline before any surface treatment is applied. Figures 3 and 4 show that Trajan's polypropylene plates, prior to coating, deliver higher purity than other commercially available plates when extracted with ethyl acetate and methanol.

24-hour extraction using 1 ppm C19 in ethyl acetate

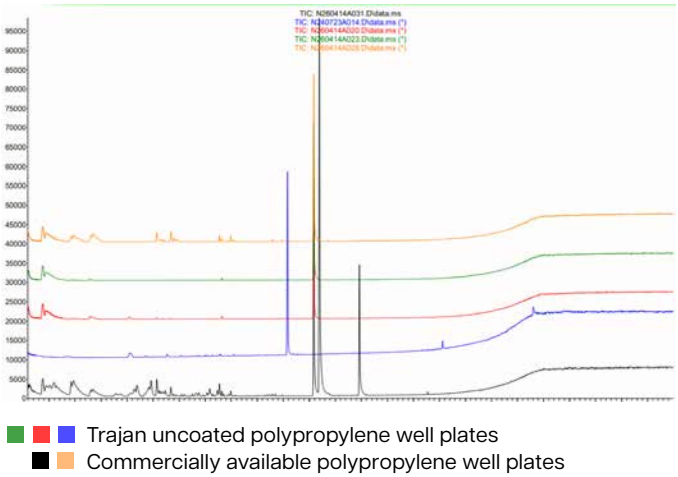


Figure 3: GC-MS chromatograms comparing the ethyl acetate extraction profiles of different batches of Trajan 96-well polypropylene plates prior to coating with those of other commercially available polypropylene plates, highlighting Trajan's consistently higher polypropylene substrate purity.

24-hour extraction using 1 ppm C19 in methanol

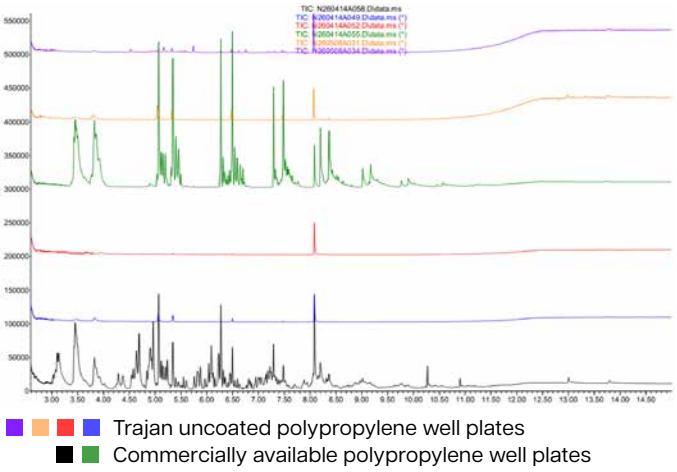


Figure 4: GC-MS chromatograms comparing the methanol extraction profiles of different batches of Trajan 96-well polypropylene plates prior to coating with those of other commercially available polypropylene plates, highlighting Trajan's consistently higher polypropylene substrate purity.

Batch-to-batch consistent cleanliness

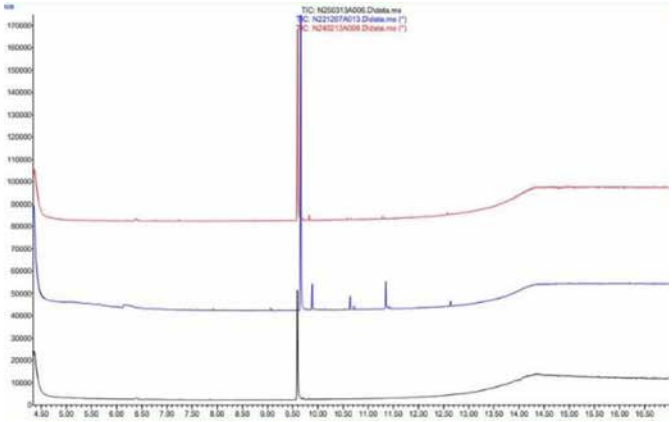
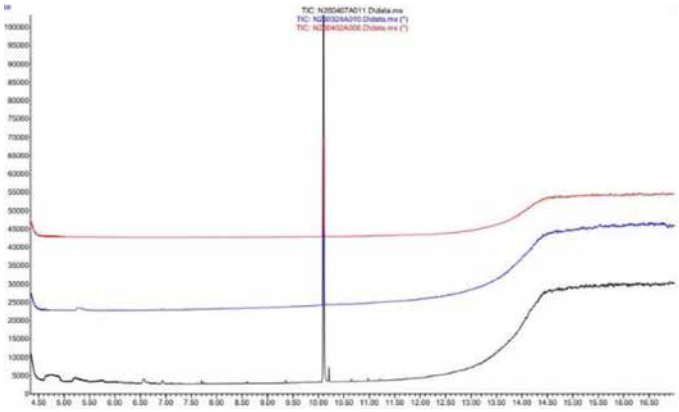


Figure 5 a



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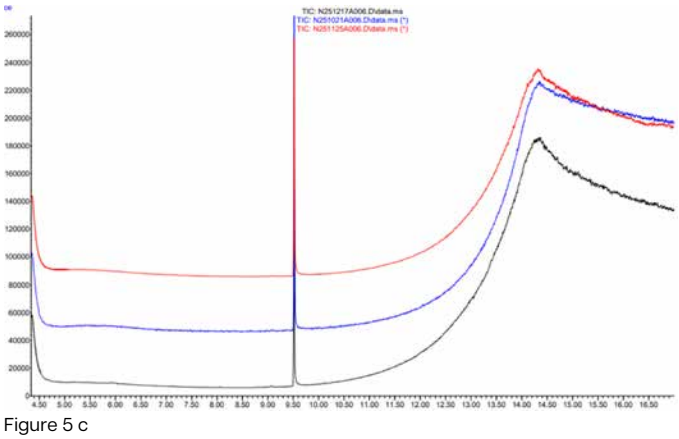

Figure 5 c

Figure 5: C19 internal standard in methanol run gas chromatography-mass spectrometry (GC-MS) sample chromatograms for 3 different plate geometries of Trajan's Pure-Pass GLC 96-well plates ALL demonstrate high level of cleanliness with some minor variation. (a) Pure-Pass GLC plates, 384 well, microtiter, V bottom, square, 125 µL, 3.8 mm (b) Pure-Pass GLC plates, 96 well, V bottom, square, 2000 µL, 8 mm (c) Pure-Pass GLC plates, 96 well, V bottom, round, 1000 µL, 7 mm

Molding in controlled conditions

Well plates are molded in a clean-room environment using high purity polypropylene, ensuring that the molding process does not introduce particulate contamination or surface defects that could compromise coating uniformity or analytical performance. Figure 5 shows GC-MS chromatograms of C19 internal standard in methanol across three Pure-Pass GLC plate geometries, demonstrating high cleanliness with minimal variation.

Glass-like coating process

The Glass-like coating is applied at Trajan's ISO accredited facility in Louisville, KY. The coating process has been developed and optimized by Trajan's surface chemistry team and is executed on advanced, dedicated equipment. Use of advanced equipment in the process enforces consistent coating parameters across all plates.

Precisely controlled process parameters directly support the product's batch-to-batch consistency and uniformity in high-volume production – a property of particular importance for laboratories operating validated methods where container performance is a controlled variable.

Quality testing and traceability

Quality assurance for Pure-Pass GLC well plates is embedded throughout the manufacturing process, not restricted to final inspection. Testing against defined product specifications is implemented at key process stages, providing early detection of non-conformance and preventing out-of-specification products from advancing in the process.

The Louisville facility operates under an ISO 9001 certification, a quality management system framework for manufacturing. This certification confirms that quality management processes, change control, supplier qualification, and customer complaint handling meet internationally recognized standards.

Full product traceability is maintained from raw material receipt through finished goods, enabling root cause investigation in the event of a quality concern and supporting the documentation requirements of regulated laboratory environments. This traceability makes Pure-Pass GLC well plates a suitable consumable for use in GMP, GLP, and other regulated analytical workflows.

Conclusion

Delivering accurate analytical results requires attention to every stage of the sample workflow – from collection and storage through preparation and presentation to the instrument. The choice of sample container is a critical, frequently underestimated variable: non-specific binding, extractables, and dimensional inconsistency can each independently compromise data quality, reproducibility, and laboratory productivity.

Trajan Pure-Pass GLC well plates address these challenges by combining the surface performance of glass with the automation compatibility and dimensional precision of a standard polypropylene microplate. The GLC technology – a Si/O coating applied via a tightly controlled process in an ISO 9001-certified facility – delivers consistent, reproducible product, as demonstrated analytically and supported by robust quality management.

For laboratories seeking to eliminate sample loss risk, improve recovery consistency, and maintain the throughput of automated workflows without compromising on surface quality, Pure-Pass GLC well plates offer a technically and operationally validated solution.

For more information on Pure-Pass GLC, visit **www.trajanscimed.com/plates**

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