CHOOSING THE BEST VIAL FOR YOUR LC AND LC/MS EXPERIMENT

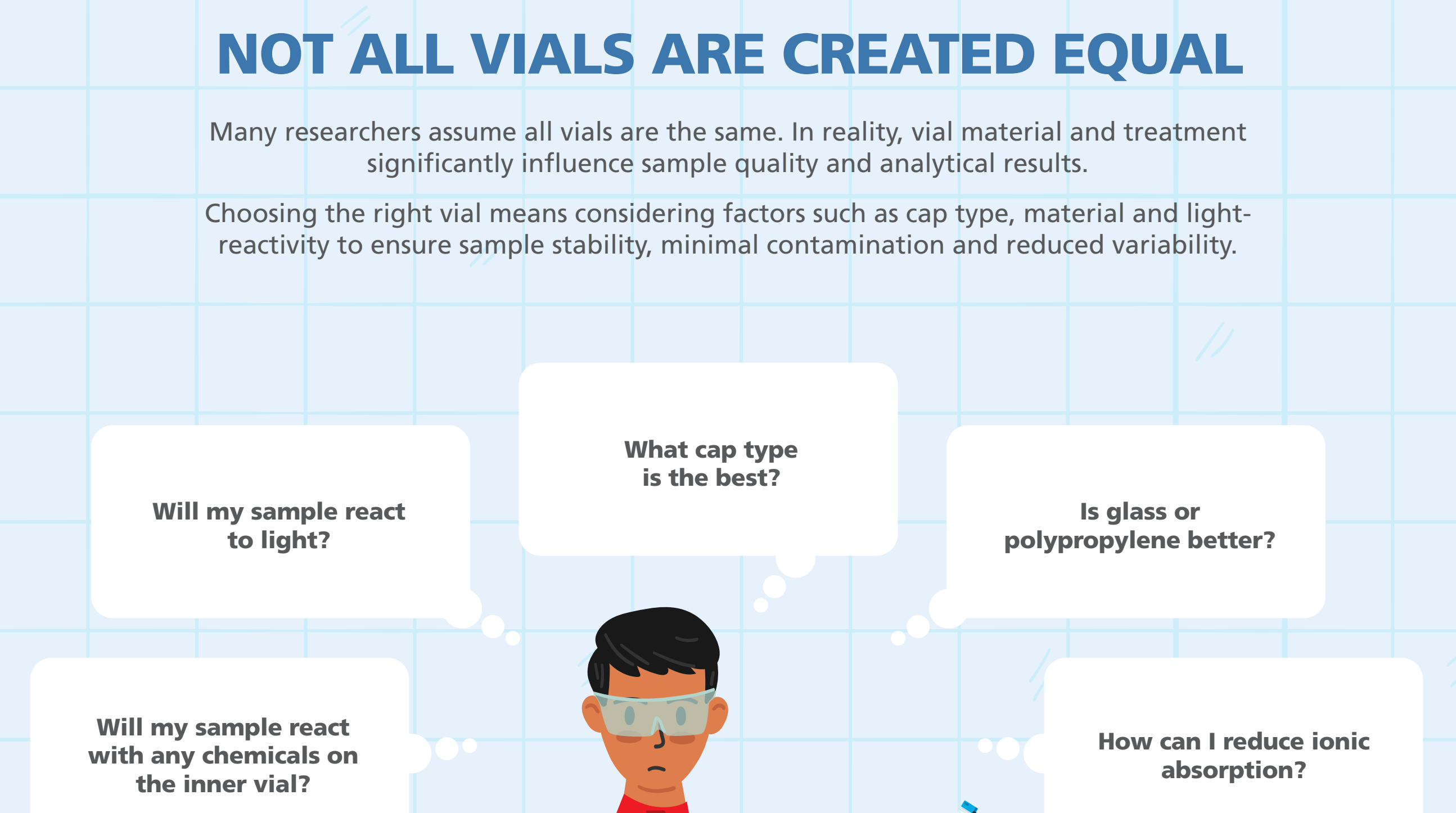
Recent advances in liquid chromatography (LC) and mass spectrometry (MS) instrumentation have dramatically improved sensitivity and selectivity, enabling the detection of target compounds at ultralow concentrations. However, the importance of optimizing vials for these types of experiments is frequently overlooked, with inconsistent results often attributed to analytical equipment or techniques instead.

This infographic explores how alkali metals in borosilicate glass vials affect analytical accuracy and suggests practical solutions to mitigate these challenges, ensuring reliable and reproducible results.

NOT ALL VIALS ARE CREATED EQUAL

Many researchers assume all vials are the same. In reality, vial material and treatment significantly influence sample quality and analytical results.

Choosing the right vial means considering factors such as cap type, material and light-reactivity to ensure sample stability, minimal contamination and reduced variability.


Will my sample react to light?
What cap type is the best?
Is glass or polypropylene better?
Will my sample react with any chemicals on the inner vial?
How can I reduce ionic absorption?

A critical aspect of vial selection is understanding the interaction between the vial's inner surface and the sample or solvent. Key considerations include:

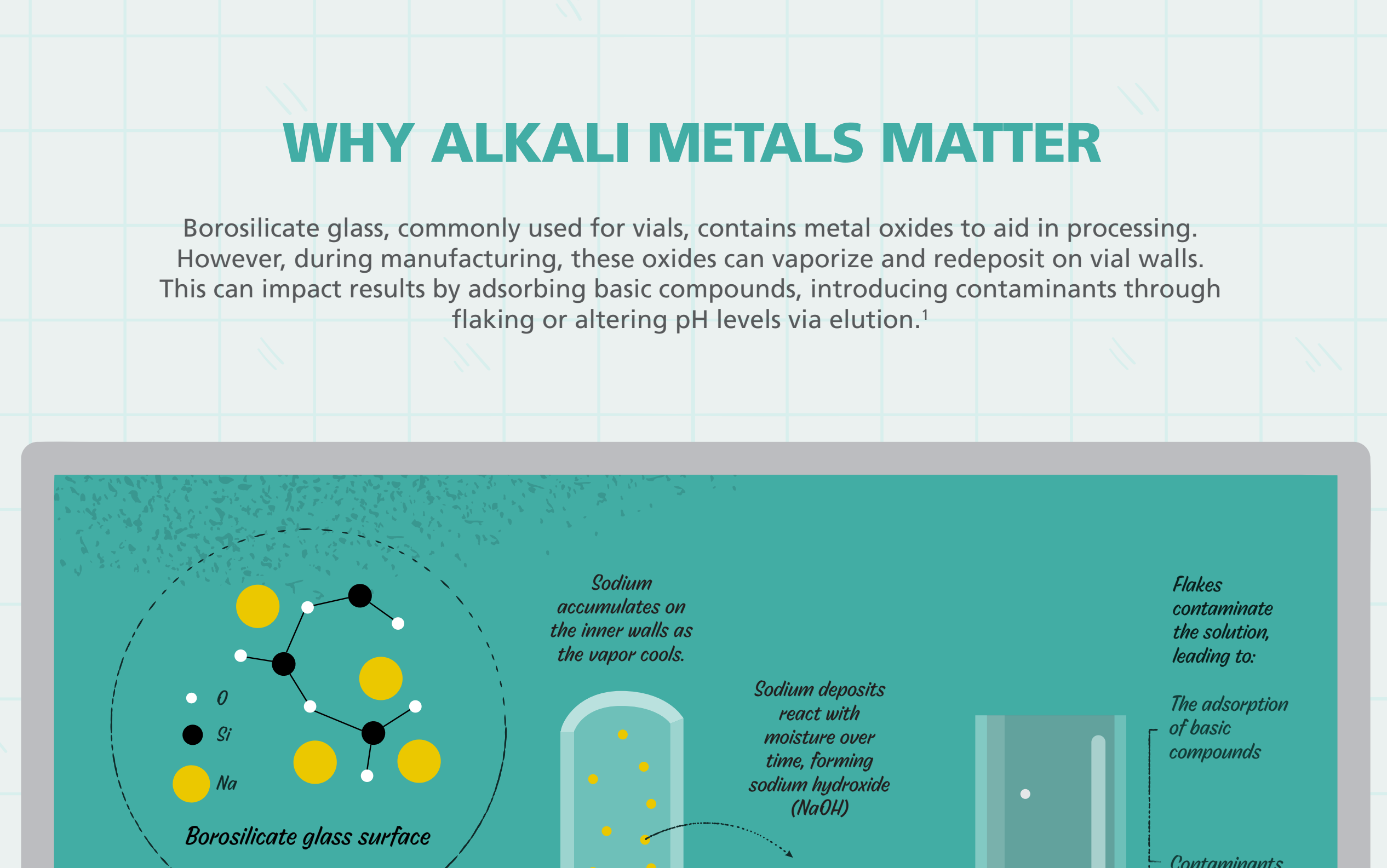
Compound stability
Preventing degradation caused by interactions with alkali metals, such as sodium

Adsorption
Minimizing ionic interactions.

Volatility
Managing evaporation of sensitive solvents or compounds.

WHY ALKALI METALS MATTER

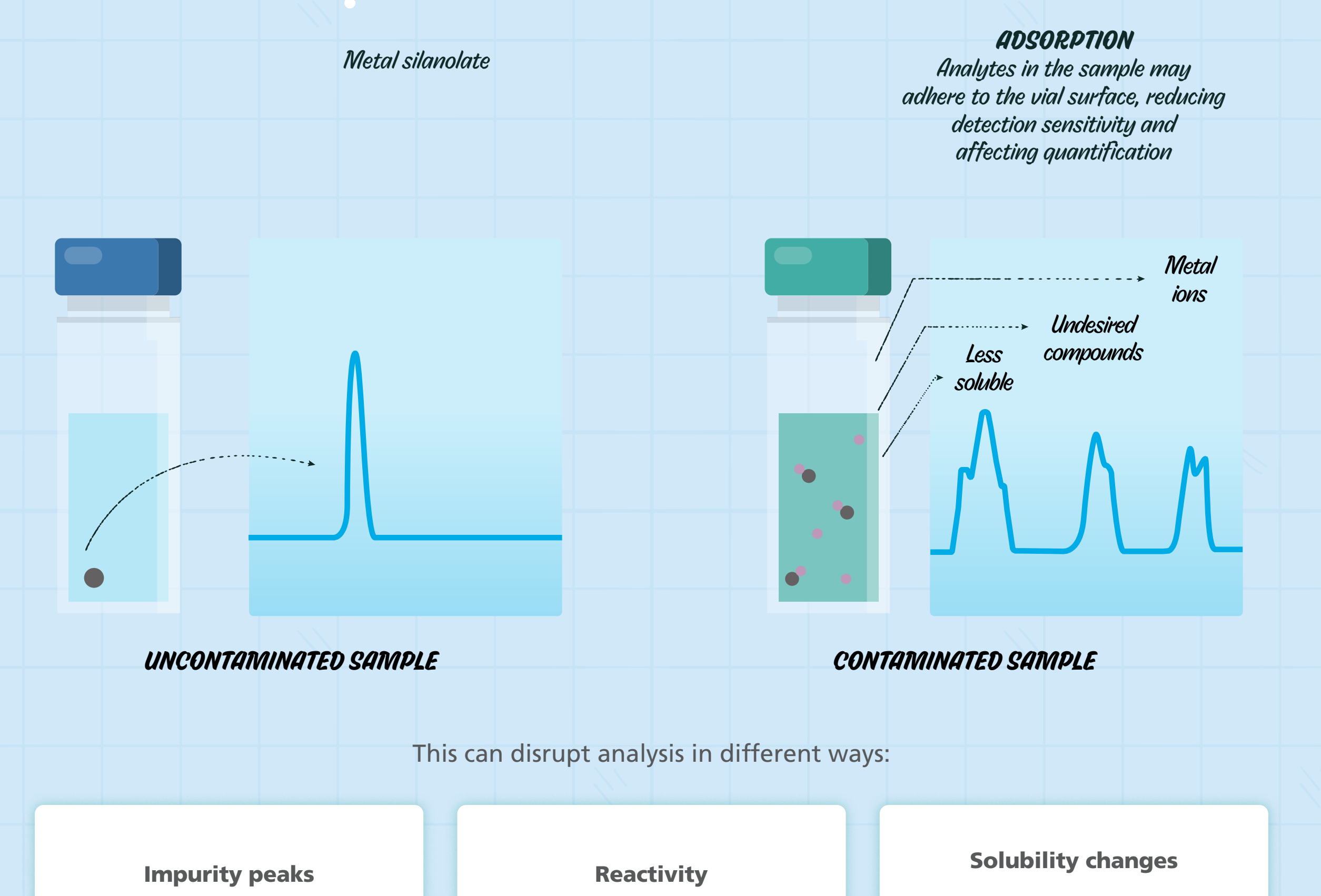
Borosilicate glass, commonly used for vials, contains metal oxides to aid in processing. However, during manufacturing, these oxides can vaporize and redeposit on vial walls. This can impact results by adsorbing basic compounds, introducing contaminants through flaking or altering pH levels via elution.[1]


O
Si
Na
Borosilicate glass surface
During the shaping process, sodium evaporates and migrates upward due to heat.
Sodium accumulates on the inner walls as the vapor cools.
Sodium deposits react with moisture over time, forming sodium hydroxide (NaOH)
NaOH
NaOH creates weak spots in the glass, causing peeling or delamination.
Weak spot
Flakes contaminate the solution, leading to:
The adsorption of basic compounds
Contaminants
Changes in pH
This process can leave you with varying results, often without a clear explanation as to why.

These effects are especially problematic in highly sensitive analyses, where even minor variations can compromise reproducibility. Therefore, selecting a vial that minimizes surface interaction with the sample is essential for accurate results.

HOW METAL IONS DISRUPT ANALYSIS

Alkali metal ions on glass surfaces can lead to critical elution and adsorption problems:


ELUTION
Released ions or compounds from the vial can contaminate the analyte, complicating analyte detection
Borosilicate glass surface
Na
Analyte
Silanol
Metal silanolate
ADSORPTION
Analytes in the sample may adhere to the vial surface, reducing detection sensitivity and affecting quantification
UNCONTAMINATED SAMPLE
Metal ions
Undesired compounds
Less soluble
CONTAMINATED SAMPLE

This can disrupt analysis in different ways:

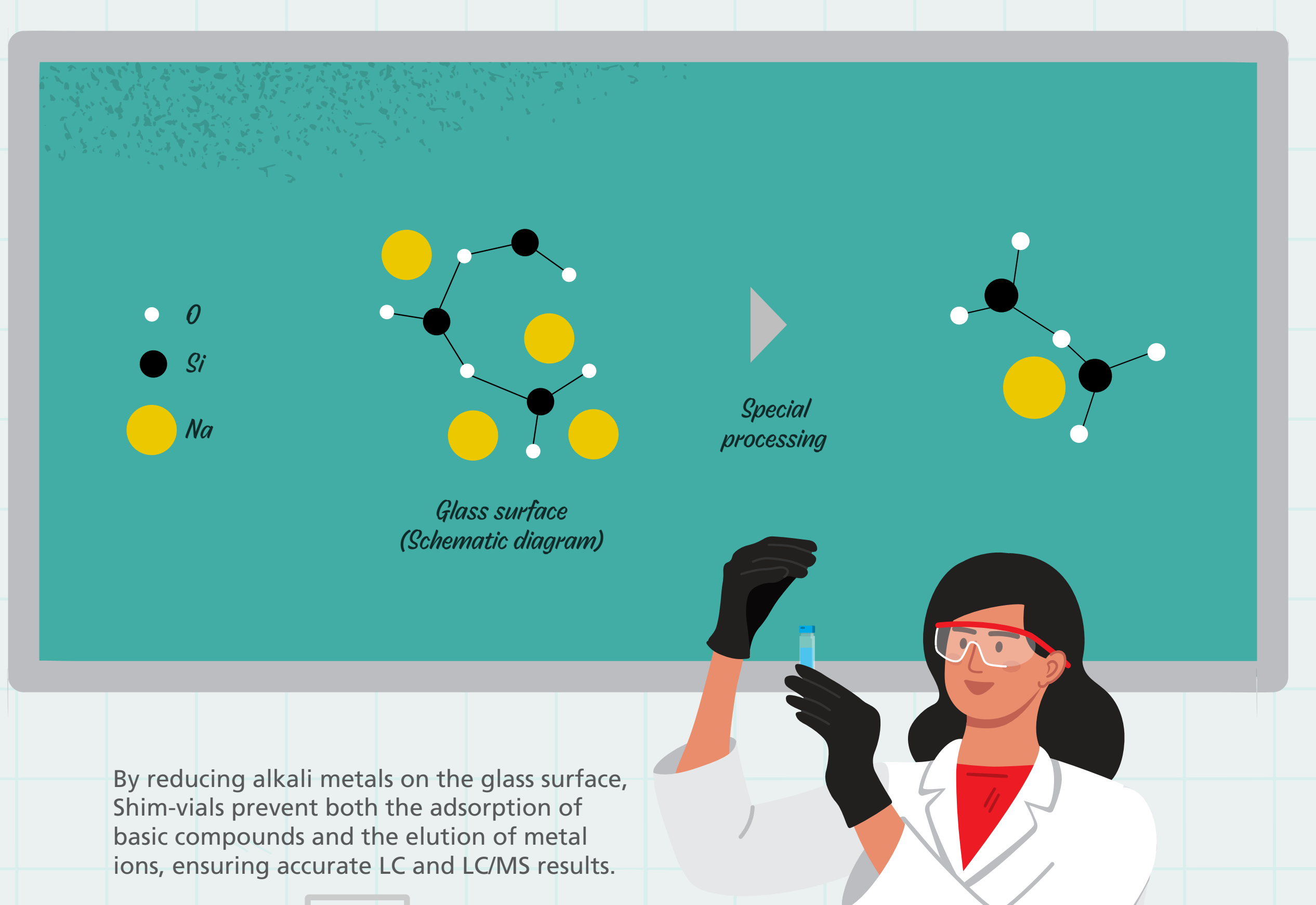
Impurity peaks
Eluted ions may appear as unexpected impurity peaks.

Reactivity
Eluates can react with analytes, forming undesired compounds.

Solubility changes
Eluates may alter the solubility of target compounds, affecting results.

LOW-ALKALI SOLUTIONS FOR ACCURATE ANALYSIS

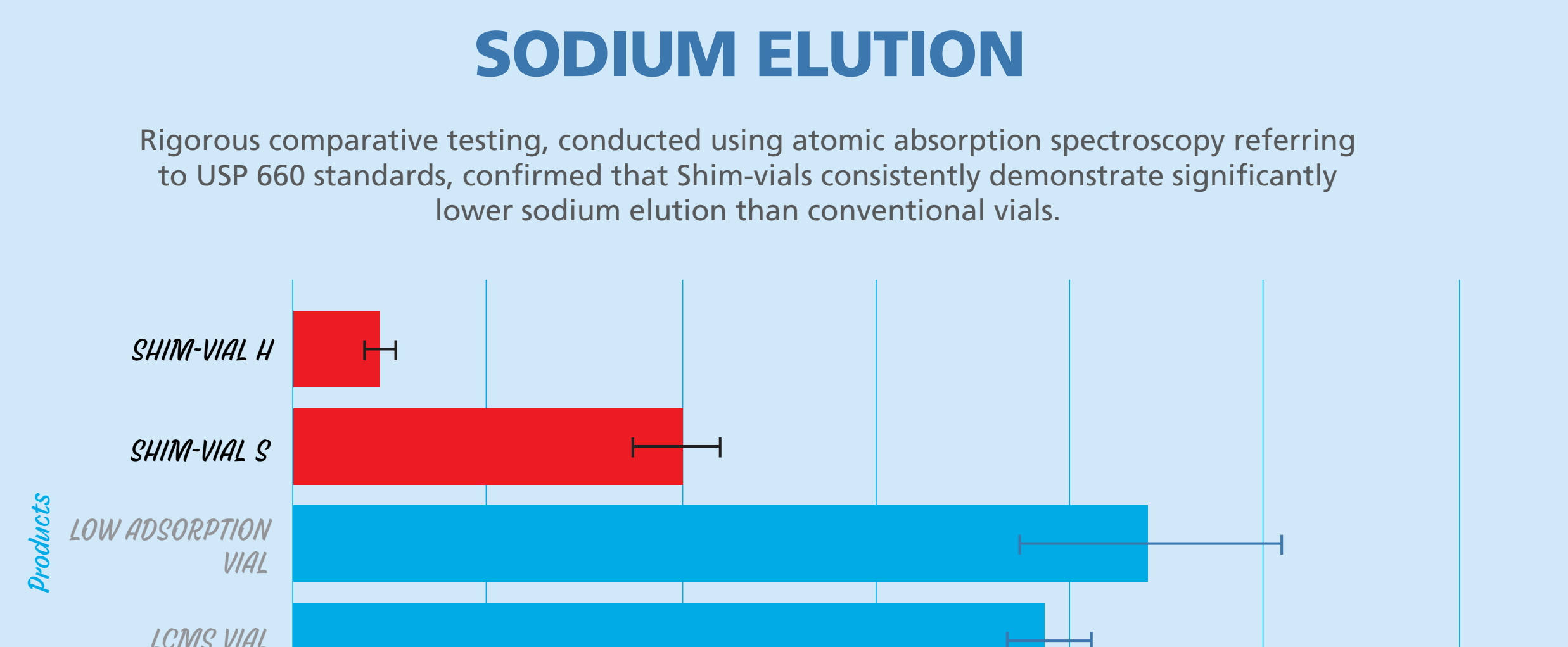
To overcome these challenges, Shimadzu developed Shim-vial™, a cutting-edge solution designed to minimize sodium elution. The Shim-vial line reduces metal ion elution through advanced low-alkali treatment during manufacturing.


O
Si
Na
Special processing
Glass surface (Schematic diagram)

By reducing alkali metals on the glass surface, Shim-vials prevent both the adsorption of basic compounds and the elution of metal ions, ensuring accurate LC and LC/MS results.

SETTING THE STANDARD FOR LOW SODIUM ELUTION

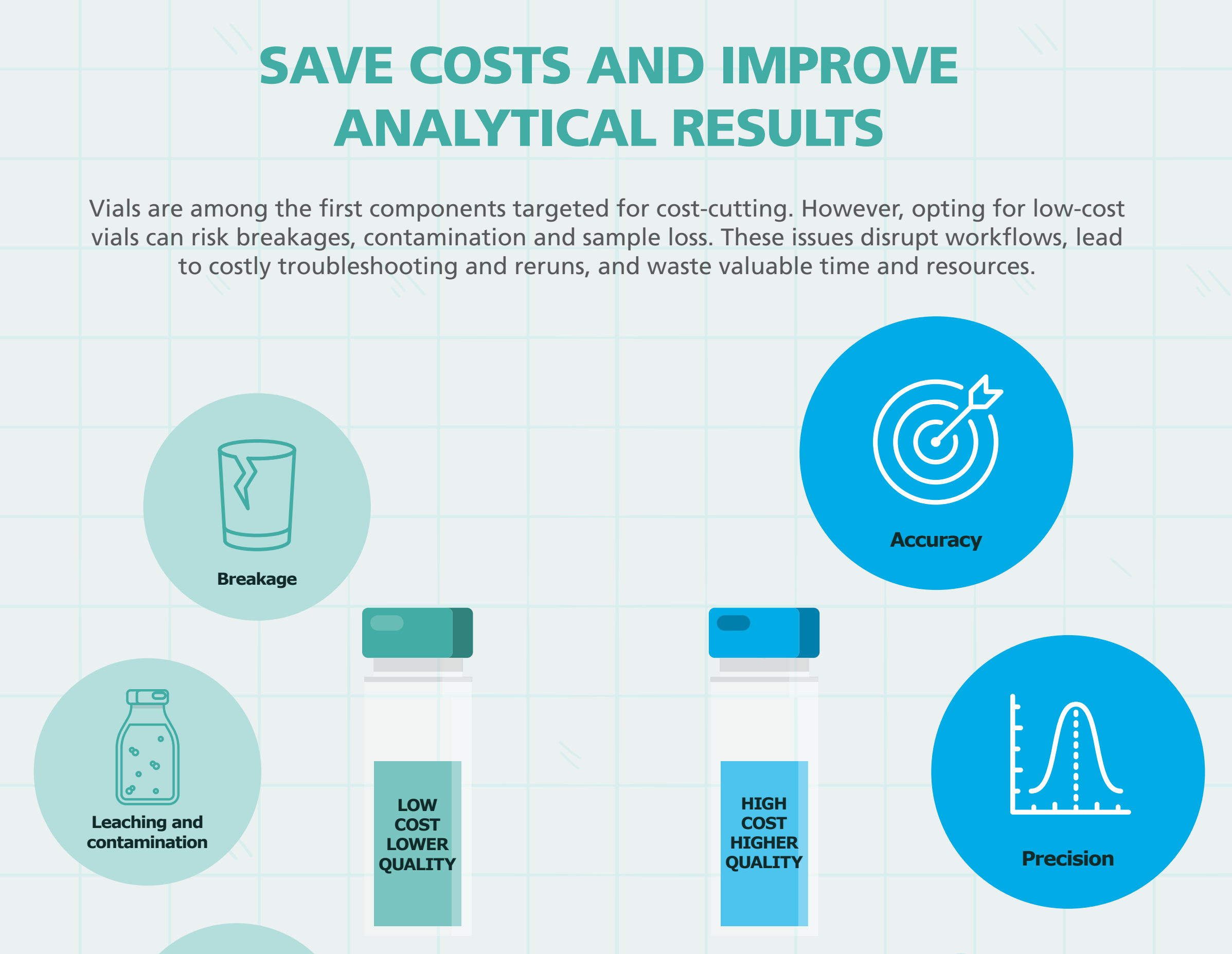
Rigorous comparative testing, conducted using atomic absorption spectroscopy referring to USP 660 standards, confirmed that Shim-vials consistently demonstrate significantly lower sodium elution than conventional vials.



Each production batch of Shim-vials undergoes thorough testing to ensure the effectiveness of Shimadzu's low-alkali treatment, guaranteeing consistent quality and reliability for sensitive analyses.

SAVE COSTS AND IMPROVE ANALYTICAL RESULTS

Vials are among the first components targeted for cost-cutting. However, opting for low-cost vials can risk breakages, contamination and sample loss. These issues disrupt workflows, lead to costly troubleshooting and reruns, and waste valuable time and resources.

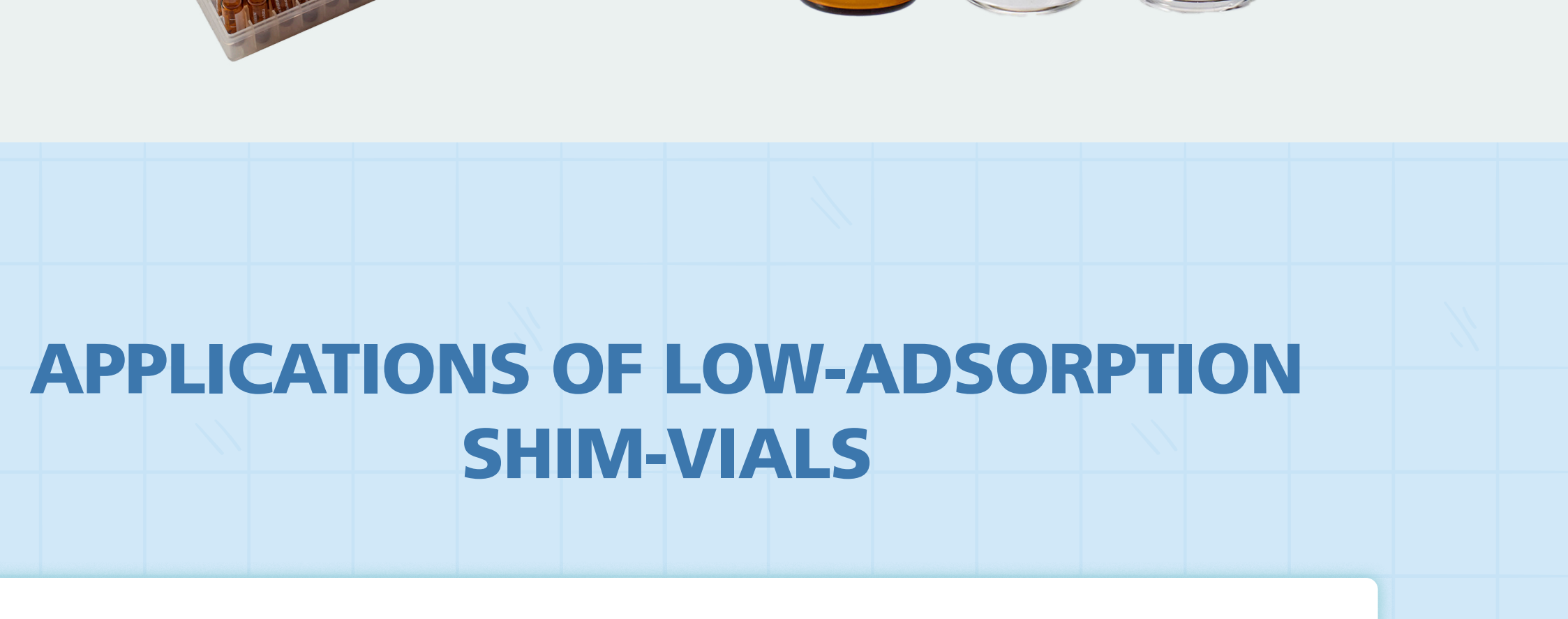

Breakage
Leaching and contamination
Sample loss
LOW COST LOWER QUALITY
HIGH COST HIGHER QUALITY
Accuracy
Precision
Validation

Lost time and money	Save time and money
Costly troubleshooting	Accurate results
Sample reruns	Higher sample throughput
Wasted time and resources	Fewer reruns

To meet diverse experimental and budget needs, Shim-vials are available in two performance levels:

Shim-vial S
Cost-effective for everyday applications
(P/N 227-34500-51)

Shim-vial H
High-performance for applications requiring maximum sensitivity
(P/N 227-34500-01)



APPLICATIONS OF LOW-ADSORPTION SHIM-VIALS

Small molecule pharmaceuticals
Small-molecule drugs with basic properties often face adsorption issues in standard vials, affecting stability over time. By reducing the adsorption of compounds to vial walls, Shim-vials ensure reliable results for pharmaceutical development and quality control.

Food safety
Analyzing pesticides and veterinary drug residues often involves substances that interact with glass or polypropylene, such as amines or highly hydrophobic compounds. Low-adsorption Shim-vials provide stability in these challenging analyses, delivering precise and reproducible results.

PFAS analysis
By minimizing hydrophobic and ionic adsorption, Shim-vials optimize the simultaneous detection of compounds with varying chain lengths and hydrophobicities, delivering precise and consistent results.

Nucleic acid therapeutics
Nucleic acid drugs often undergo chemical modifications, resulting in complex physical properties. For oligonucleotides with hydrophobic or ionic adsorption challenges, Shim-vials provide an optimal solution, ensuring reliable analytical performance.

Environmental analysis
Environmental pollutant analysis requires simultaneous detection of diverse components with varying physical properties. Low-alkali treated Shim-vials reduce interactions with a wide range of chemicals, making them ideal for multi-component analyses.

Shim-vial's innovative low-alkali treatment minimizes adsorption and elution effects, ensuring more reliable and reproducible results. By reducing impurity signals and supporting accurate peak detection, Shim-vial optimizes LC and LC/MS performance, making it an essential tool for high-sensitivity analyses for different applications.

DISCOVER THE DIFFERENCE SHIM-VIALS CAN MAKE IN YOUR ANALYSES

Shim-vial is a trademark of Shimadzu Corporation or its affiliated companies in Japan and/or other countries.

References
1. Gamal Abd-Elsatar A, Elsayed H, Kanková H, et al. Ion-exchange enhancement of borosilicate glass vials for pharmaceutical packaging. *Open Ceramics*. 2024;20:100689. doi:10.1016/j.oceram.2024.100689