

Gas plasma as a tool to effectively clean, activate, or functionalize glass.

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Glass has a variety of uses which include microscope slides and optic lenses. For different applications, the cleanliness and preparation of glass is extremely important. Some of these applications include: optical lens cleaning and activation prior to IR coating or anti-scratch coating, optics cleaning for laser applications, glass slide cleaning prior to microarray use or nitrocellulose coating, and glass bonding such as glass to glass, and glass to metals or polymers. Gas plasma can be used to clean glass on the molecular level, chemically activate, and functionalize the surface of glass.

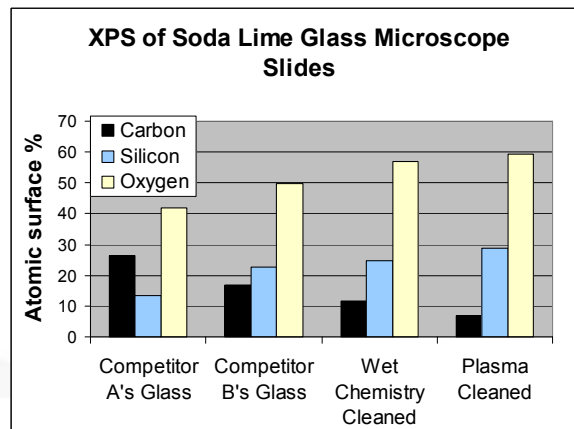
What is plasma?

Plasma is a state of matter just as a solid, liquid or gas. Add enough energy to a gas and it becomes ionized into the plasma state. Chemically it is a highly reactive environment that is used to change the properties of surfaces without affecting the bulk material.

Plasma processing is capable of removing organic contamination at the molecular level subsequent to machining, tooling and wet chemical processing steps. Plasma cleaning acts on surfaces in a conformal fashion, not only for substrates of complex geometries but also on textured surfaces with “rough” topographies.

Precision plasma surface cleaning

Using x-ray photoelectron spectroscopy, elemental surface atomic species were measured on soda lime glass microscope slides as a function of different grades of microscope slides. High signals from carbon indicate high levels of organic contamination, where as high signals from silicon and oxygen indicate a clean surface.



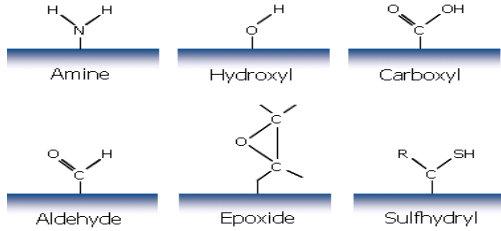
Bar chart showing relative atomic percentages of carbon and silicon as a function of different microscope slide glass, performed at PVA TePla America.

From the graph above it is clear that the highest signals from silicon and oxygen, and the lowest signal from surface carbon come from the plasma treated surface. Competitor A and Competitor B's glass both claimed to be premium and ultra clean, but from the results, it is clear that the microscope slide that was plasma cleaned showed the lowest level of surface contamination. The glass slide which was wet chemistry cleaned, went through the following steps: sonication, acid wash, overnight base wash, double distilled H₂O wash, and N₂ gas dry. The plasma cleaned glass slide was treated with plasma for 10 min.

Gas plasma has another advantage over wet chemistry in that only gases are used. This means that chemicals never need to be disposed of which can be costly and can pose environmental risks. Also, the results from gas plasma are highly reproducible, where as sonicators, used with chemicals to clean glass, accumulate organics and debris which can affect the accuracy of cleaning. Once glass has been plasma cleaned, there is no window for shelf lifetime.

Plasma surface activation

By raising the surface energy of glass, the surface becomes readily available to adhere to cells and bio molecules, which is important in the life sciences. In addition, once the surface activation is increased, functional groups can be deposited via a PECVD-like process.



Above are functional groups that can be deposited onto glass surfaces using gas plasma processing.

A quick way to tell if a surface has a higher surface energy after plasma treatment is to perform a contact angle test. If the water droplet beads up on the surface, then the surface is hydrophobic. If the water droplet disperses on the surface, then the surface is hydrophilic, indicating a higher surface energy.

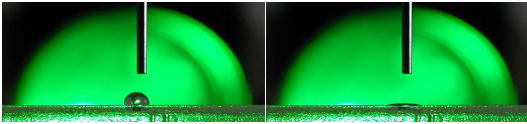


Image of a hydrophobic surface before plasma treatment (left) and an image of the hydrophilic surface (right) after plasma treatment.

Surface activation can also be used for adhesive free bonding. For example, it is possible to adhere silicone to glass microscope slides directly after the surface energy of the glass slides has been increased. Once bonded, the silicone and glass microscope slides just need to be heat cured to promote a strong bond. This provides an adhesion free method, which is advantageous if the glass slides need to be free of contamination left from adhesives.

PVA Tepla America offers an atmospheric plasma pen, which can quickly raise the surface energy of glass directly before adhesion. The surface energy activation window lifetime is around 30 minutes, so it is best to adhere or functionalize the glass directly after raising the surface energy.



IoN 40 vacuum plasma chamber (left) and atmospheric plasma pen (right).

Summary

Gas plasma is an excellent means of precision cleaning, activating, and adding functional groups to glass. With gas plasma, wet-chemistry methods can be avoided and a reliable and consistent surface treatment can be achieved.

What does PVA TePla America offer?

At PVA TePla America we offer a full line of vacuum and atmospheric gas plasma systems. Our reliable, easy-to-operate products deliver some of the most advanced and innovative solutions in the world for a wide variety of industrial applications. We also offer clean area contract processing services with ISO 9001:2000 certification. We are experienced conducting FDA trials and developing CFR Part 11 compliant software.

Additionally, we offer free proof of processing as an incentive to evaluate our plasma technology. This allows you to access gas plasma technology without up front capital expenditure on labor and/or facilities.



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