Chamber Design and Adhesion Strength

An increasingly important application of plasma is in the modification of surfaces prior to bonding.

We were recently involved in a customer revue of several plasma cleaners offered by different vendors. The purpose was to evaluate the degree of modification (and associated bond strengths) from each system with a given fixed set of operating parameters.

An accepted test of the degree of surface modification is in the wettability of a surface after cleaning. Here, the extent to which a water droplet will migrate across a surface is in direct proportion to the wettability achieved and the greater the wettability, the stronger the bond. A partially modified surface will result in more beading of a droplet of water than a fully modified surface on which the droplet will, ideally, flatten completely.

The instrument used to measure the degree of beading is called a goniometer and the contact angle ($\propto$) is measured as shown in *figure 1*.

The results ranged from a contact angle of 12° (poor) to a contact angle of 5° (good), depending on the system used.

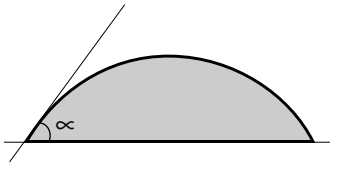
A review of the mechanism of ablation (or surface modification) shows that to achieve maximum effect, the surface must be:

(A) Subjected to as high a concentration as possible of the active plasma species. This requires that the gas within the chamber be constantly replenished so that recombined and bi-product molecules are removed to exhaust as soon as they are formed and replaced with activated plasma gas.

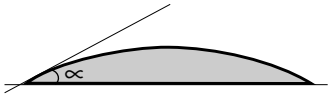
(B) Maintained at uniform temperature as ablation rate is directly proportional to the temperature of the surface.

For repeatable results, the entire chamber must be evenly purged and maintained at uniform temperature so that no preferential area exists. Obviously then, the design of the chamber and plasma gas circulation is critical to achieving uniform results.

It was quickly noted that chamber designs with inputs located adjacent to outputs gave the poorest results due to “dead areas” formed within the chamber *(figure 2a)*. The superior (5° contact angle) was achieved by Glen Technologies 1000P, the only system tested that used a full chamber laminar gas flow *(figure 2b)* to directly address items (A) and (B) above.

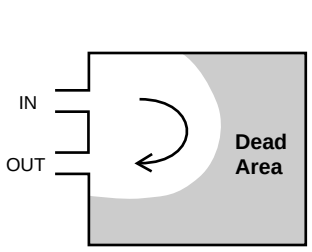


Poor surface modification resulting in droplet beading

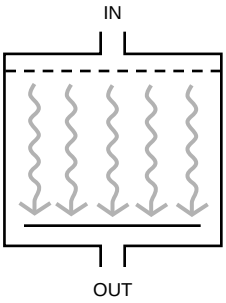


Good surface modification resulting in minimal beading

Figure 1



(a) Poor chamber design allowing dead spots where lack of gas flow permits local heating and depletion of atomic species.



(b) Good chamber design where vertical laminar flow constantly purges the chamber of hot gases and recombined species.

Figure 2

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