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Microwave-induced Atmospheric Plasma Jet – Design and Applications

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A self-igniting 2.45 GHz microwave-induced atmospheric plasma jet (MAPJ), shown in Figure 1, belongs to the type of devices called waveguide-surfatron. Figure 2 illustrates the plasma chamber, which is enclosed by a quartz tube. To prevent the quartz wall from melting, a "shield" gas is fed through the eight inlets that surround the central inlet where the working gas is fed. Typically argon is used as the working gas (as it is easier to breakdown to form the plasma) and nitrogen is used as the "shield" gas. The use of the shield gas is adopted from the design principles of plasma torches. For some applications, the nitrogen shield gas is replaced by compressed air not only to lower the cost of operations but also to exploit the more concentrated presence of oxygen. The shape of the plasma used for the treatment can be modified by the different types of nozzles one can use, shown in Figure 3.

MAPJ can readily treat the surface of different materials for the purpose of creating hydrophobic or hydrophilic surfaces. In one experiment the Ar-N2 plasma produced by MAPJ activated the silicone applied on a glass surface to make it hydrophobic. This is evidenced by the change in the chemical properties of the treated surface compared to the untreated one, as shown in Figure 4. Also, with a slight change in the configuration of the system, Zno/Zn and ZnO film was also deposited on a soda lime glass substrate.

While atmospheric plasma devices have a more limited range of applications compared to vacuum plasma devices, they offer greater flexibility and ease of use within their capabilities.

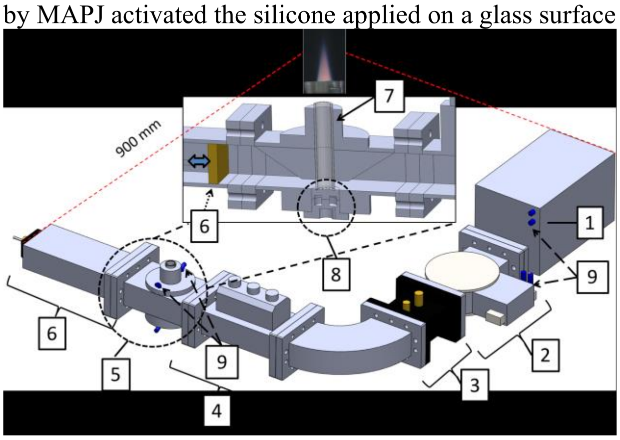

Figure 1. Model of the microwave plasma jet device; indicated are the ff. parts: 1. Magnetron head, 2. Isolator assembly, 3. Directional coupler, 4. Three-stub tuner, 5. Tapered waveguide, 6. Sliding short, 7. Discharge tube, 8. Gas feed channels, 9. Cooling water inlets/outlets; Shown also is a photo of a plume from the plasma jet.

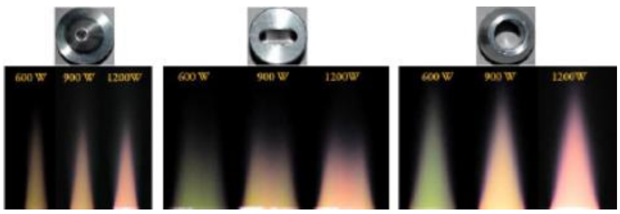

Figure 3. Different nozzle attachments for the jet. (left-right) pen, brush, and cone respectively. Also shown below are photos of the afterglow generated with each nozzle.

References

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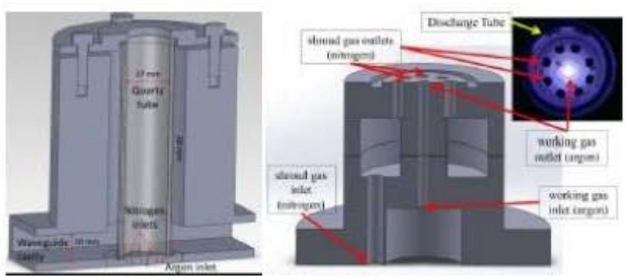

Figure 2 Model of the gas feed system showing the channels for the working gas (argon) and the shield gas (nitrogen). Inset photo shows the actual outlets along with a plasma discharge.

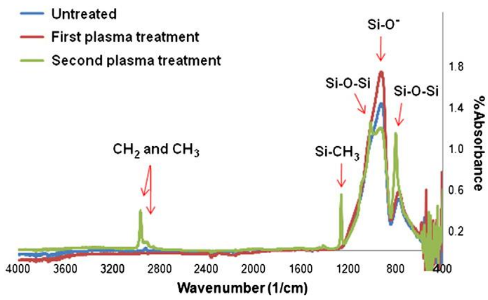

Figure 4. FTIR spectra of the untreated and plasma-treated glass surfaces.