Plasma Technology Transforms Traditional Paint Line into High-Speed Compact Line

3-D parts can be treated with robot.

By Daniel Kaute

One of the main advantages of UV coatings and inks is a compact and shortened production process. However, difficulties in adhesion to substrates, such as polypropylene (PP), polyethylene (PE) and thermal plastic olefins (TPO); relative cost; and general unfamiliarity with the UV-curing process have hindered a broader spread of the technology to date.

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A unique new atmospheric pressure plasma technology makes it possible to overcome many of the limitations of UV technology. The technology is a key element in implementing a compact paint line without cumbersome power wash. It is being used in more and more UV painting and printing applications.

How Atmospheric Pressure Plasma Works

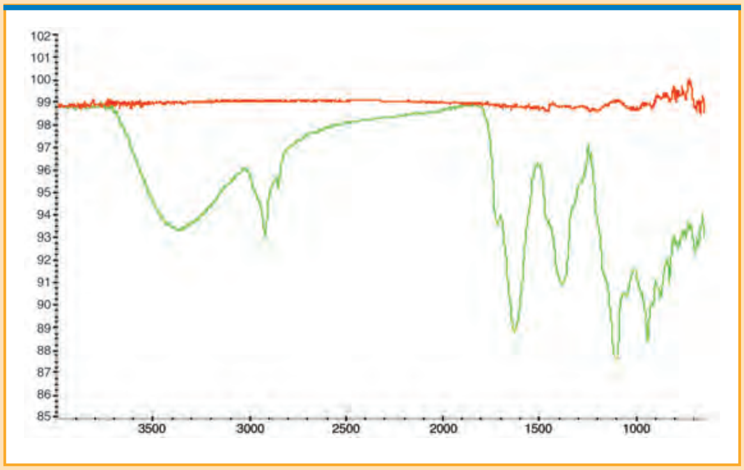
Atmospheric pressure plasma consists of a stream of highly accelerated, high-energy electrons and ions that are projected at high speed to the surface. The combination of atmospheric pressure plasma with high-power blasting makes the process very effective.

The blasting process exposes the structural backbone of the material and removes low-molecular weight organic- and silicone-based contaminations. The degree of cleaning is much higher than most other industrial processes and can, for instance, replace a multi stage power wash. The effect can be shown with infrared (IR) spectroscopy and similar examination methods (Figure 1). The second effect of blasting the surface with an overall neutral stream of electrons and ions is to eradicate electrostatic charges and to blow away electrostatically attracted dust. The third effect is mainly valid for polymer-based materials, especially those with low-surface energy. Where air or oxygen is used as a carrier gas, a considerable degree of oxygen is implanted onto the pristine surface, leading to a high amount of ketonic

Figure 1

IR spectroscopy of Al surface before (green) and after (red) plasma surface preparation {% transmission plotted over wave number (cm -1)}.

Pressure plasma technology leads to a pristine surface down to molecular levels.



and hydroxyl groups. For example, up to 30% oxygen has been measured by XPS analysis on TPO after treatment, compared to 10% with corona treatment. The combination of the three effects typically leads to greatly increased wetting and bonding capability (Figure 2).

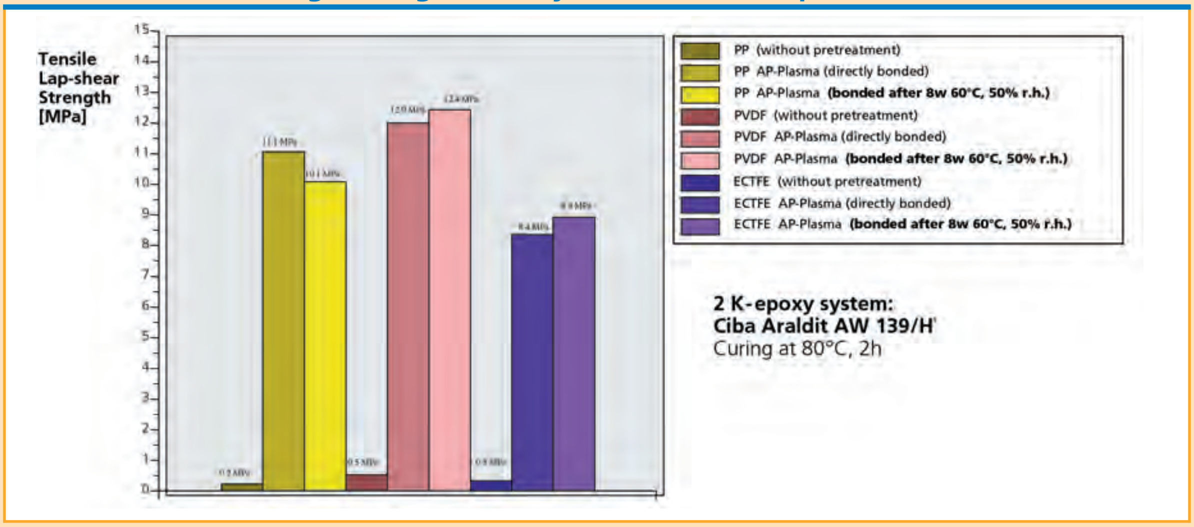
The treatment is highly homogeneous and has a typical static temperature of only 200°F. It is also very safe as it is voltage free and can be touched without harm. Various jet types allow the process to be adapted to most industrial requirements including flat substrates, linear extrusion and 3-D components. The atmospheric pressure plasma systems described have been implemented industrially since 1995. The following case studies show how these systems have led to high performance and environmentally friendly and cost-effective coating solutions.

Tackles Dust Problems

Dust is an enemy to paint and plating processes, and plasma technology is being used as a weapon to combat it. For example, in facilities where molding and paint operations are separated, dust from cardboard,

Figure 2

Tensile lap shear strengths of plastic bonds with and without plasma surface preparation (courtesy Fraunhofer Institute for Processing Technology and Materials Research). Bond strength is significantly increased after plasma treatment.



plastic or various fibers (such as clothing, hair, etc.) regularly come into contact with the molded parts that are shipped into the paint facility. In one facility, employees were vacuuming racks and used lint-free rags, deionized water and de-stat guns to fight the dust. Atmospheric pressure plasma blasting the racks in a fully automated operation has now replaced those steps and led to overall lower scrap rates. In the cited example, scrap went from 10% to approximately 2%. Application examples include automotive headlamp lenses and cell phone covers.

Eliminates Power Wash and Adhesion Promoter

UV technology only saves space and time at the end of the paint process. It does not help replace a multi-step power wash facility. The plasma technology has shown in many applications that it can eliminate power wash and the use of an adhesion promoter even on difficult substrates like TPO, PP and PE. Moreover, many UV coatings only achieve adhesion, when they are presented with a micro clean and highly activated surface. Thus, materials that are normally difficult for UV coatings show excellent adhesion after plasma surface preparation, considerably broadening the application outlook of UV coatings. The high and uniform activation of parts also leads to a more uniform film build, which typically reduces the overall coating use by 20% and avoids scrap due to fish eyes and craters.

Conclusion

Atmospheric pressure plasma can be used to build a high-speed compact paint line, where plasma cleaning follows molding then paint application and UV curing respectively. Difficult to adhere to substrates like TPO, PP and PE can be reliably coated. This considerably adds to the attractiveness of UV technology, where compactness and speed are key selling factors.

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