

Surface functionalization of three-dimensional components by means of atmospheric-pressure plasma

More and more frequently, selectively activated and functionalized surfaces are required for applications in the fields of biotechnology and medical technology. Commercial treatment systems for the non-specific plasma activation of three-dimensional components at atmospheric pressure already exist. On the other hand, so far special chemical groups can only be generated on the surface by means of complex wet-chemical processes or low-pressure plasmas. In order to place special chemical groups on substrate surfaces of this kind at atmospheric pressure, a RotoTEC installation at the Fraunhofer IST was modified so that it was possible to work even at a defined gas atmosphere.

Modification of the installation

To reduce the oxygen content in the installation while simultaneously minimizing process gas consumption to less than 100 ppm, an encapsulated process chamber and an automated lock feature was integrated into a RotoTEC installation manufactured by Tantec (fig 1.). First investigations clearly indicated the differences in the intensity of the plasma when the process gas was varied.

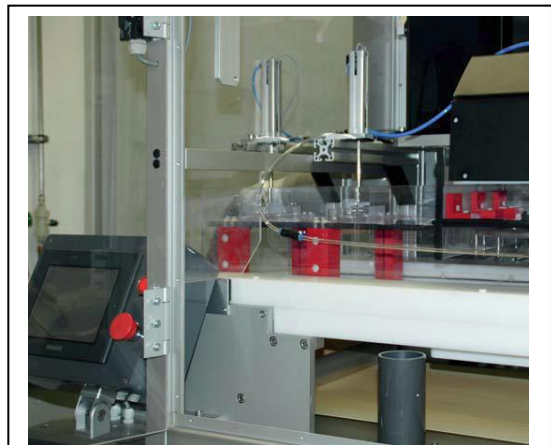


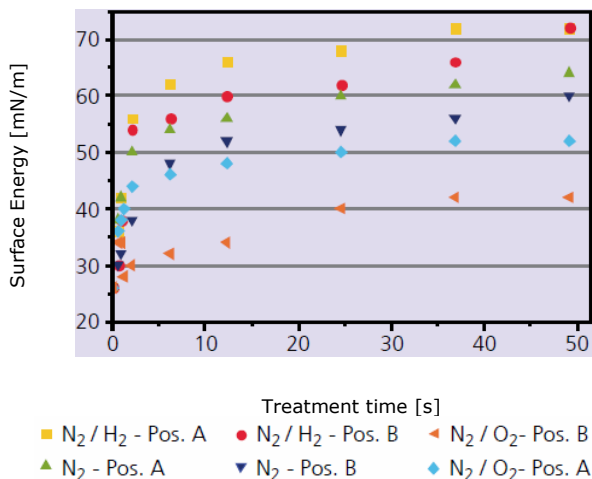
Fig. 1: RotoTEC installation with an encapsulated process chamber and automated load lock features.

Particularly when nitrogen and forming gas are used, higher power levels could be used with the same electrode distances or greater electrode distances were possible.

Surface activation

The influence of the treatment time and of the process gas as a function of the distance between the electrode and the substrate surface and geometry was investigated. Some polypropylene film was attached to a small plastic box so that it covered the top face and the longitudinal sides. Treatment was

Fig. 2: Dependence of surface tension, the treatment time, the distance from the electrode, and the process gas.



carried out at an electrode distance of 70 mm and power levels of 600 W (air), 850 W (nitrogen) or 800 W (forming gas). The surface tension was measured by means of test inks. In contrast to activation at the air, considerably higher surface tensions on polypropylene could be obtained with treatment with nitrogen and forming gas (Fig. 2). Even the dependence of the distance on the electrode is no longer so marked since sliding discharges over the surface result in homogenization of the treatment.

Aminofunctionalization

Further investigations were carried out into whether primary amino groups can be generated on the surface by means of treatment with forming gas. These groups play an important role in, for example, how adhesives adhere and in the docking of biomolecules. Accordingly, the polypropylene film was functionalized while varying the treatment time and the hydrogen concentration. At position A more than 12 amino groups could be counted per nm^2 , with a linear relationship to the hydrogen concentration being detected and a logarithmic relationship to the treatment time (Fig. 3).

Outlook

In the future the results are to be transferred to three-dimensional technical components such as micro titration plates (Fig.4) and investigations will be made into the docking of biomolecules, the generation of further functional groups and into wet-chemical metallization.

Contact

Fraunhofer IST Braunschweig Germany
Dr. Michael Thomas
Phone : +49 531 2155-525
michael.thomas@ist.fraunhofer.de

Tantec A/S, Denmark
Phone : +45 7558 5822
www.tantec.com
sales@tantec.com

Fig. 3: Number of amino groups as a function of the treatment time and the hydrogen concentration.

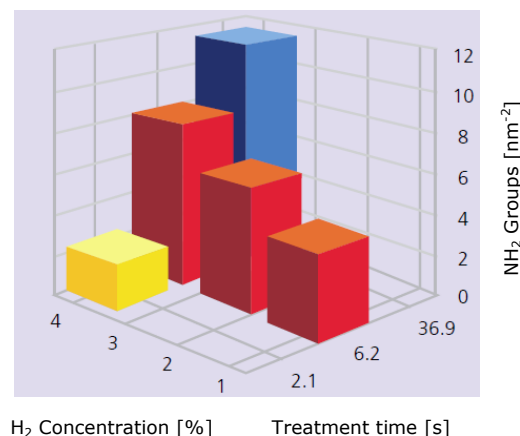


Fig. 4: Treatment of Micro titration plates

