Surface functionalization and nanostructuring of polymers using non-equilibrium gaseous plasma

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Surface properties of polymers and polymer composites are rarely adequate so they should be modified prior any further treatment such as painting, printing, gluing or grafting. A suitable technique for tailoring surface properties of such materials is a brief treatment with non-equilibrium gaseous plasma. Reactive gaseous species readily interact with the polymer surface even at room temperature causing functionalization, etching and sometimes also modification of sub-surface layers. Surface properties of practically all polymers can be tailored in a broad span from super-hydrophilic to super-hydrophobic surface finish but the suitable plasma parameters vary enormously for different materials. Nano-structuring is a spontaneous process that takes place upon treatment of a polymer with rather aggressive plasma whose reactive gaseous species cause etching. Typically, oxygen plasma or a mixture of oxygen and another gas is used to tailor surface morphology. The required treatment time is often as low as a second, but many authors prefer prolonged treatment times up to several minutes. The rich surface morphology of plasma-treated polymers that may be original almost perfectly smooth allows for superior surface finish. In the case super-hydrophilicity is the desired surface finish, the nano-rough polymer surfaces should be functionalized with polar functional groups what is often accomplished by a brief treatment with oxygen reactive species. Preferred are neutral O-atoms in the ground state because they allow for a very high concentration of polar functional groups on the polymer surface. In the opposite case when super-hydrophobic surface finish is desired, the final functionalization is performed using reactive gaseous species formed in CF_4 plasma. In many cases, the surface of polymer is saturated with desired functional groups after achieving the fluence of 10^{21} m^{-2}, what happens upon plasma treatment in a fraction of a second providing the plasma properties are optimized. Several practical examples suitable for industrial application will be presented.