In-situ Spectroscopic and Kelvin Probe Studies of the Modification of Solid Surfaces in Low Temperature Plasmas

Abstract

In recent years cold plasmas have been used in different ways to achieve functional properties on polymer, metal and semiconductor surfaces. In most cases ultra-thin surface layers determine the properties of the modified system. The chemical composition and the electronic properties of oxide covered surfaces strongly influence the corrosion behaviour of the materials as well as their adhesive properties. In case of polymeric substrates, the chemical composition, density and orientation of polar groups which are introduced in non-polar substrate surfaces by means of plasma modification are of interest.

To reveal principle processes of surface modification in reducing and oxidizing low temperature plasmas an analytical setup have been designed that allow in-situ studies of the plasma modification. It combines FTIR spectroscopy for the characterization of the surface chemistry with a sensitivity down to sub-nanometer range and a Kelvin probe for determination of changes of the work function of the modified surfaces. The work covers the surface modifications of a model polymeric surface, oxide covered surfaces of iron, aluminum and $MgZn_2$ in vacuum plasmas in different gas atmospheres as well as the modification of silicon in a dielectric barrier discharge and in an ozone atmosphere. The surface modifications are proved by complementary ex-situ XPS. Scanning Kelvin probe measurements on plasma modified and polymer covered $MgZn_2$ will be presented to discuss aspects of polymer/metal adhesion and corrosion. Changes of the adsorption kinetics of phosphonic acids on plasma modified, oxide covered aluminum will be proved by quartz crystal microbalance measurements.