Josef Pühringer, Pichlwang 18, 4502 St.Marien

Diploma Thesis

Title: Surface Modification of Poly(tetrafluorethylene) by UV-Excimer Laser Light and its Characterization

Charged by: Univ. Prof. Dr. Dieter Bäuerle

At: The Institute of Experimentalphysics, Department: Applied Physics, at the Johannes Kepler University in Linz.

Background: Poly(tetrafluorethylene) (also called Teflon) is a very desired material for the production of e.g. printed circuit boards and low adhesion coatings. There are problems with the practical usage of this material because of the low adhesion of other materials on Teflon. The adhesion can be increased by irradiation with UV-light in a water bath.
The task of this diploma thesis consisted in the investigation of the correlations between the better adhesion and the chemical changes at the surface.

Abstract (from the diploma thesis)

Motivation The low dielectric constant, the low dielectric dissipation-factor, the good chemical and thermal stability, the low moistening by water and fats and the low adhesion of poly(tetrafluorethylene) open a broad field of applications in medicine and technique. But the low adhesion of poly(tetrafluorethylene)-films on other materials leads at the same time to problems in the production of devices.

One method of modifying the surface of poly(tetrafluorethylene) is the irradiation with UV-excimer-laserlight in a photochemical active media. This is examined in this thesis.

Contactangle The contact-angle of water on poly(tetrafluorethylene) is distinctly reduced by the irradiation with the UV-light of a excimer-laser with 193 and 248 nm. The observed contact-angle-hysteresis is increasing with rising reduction of the contact-angle. The irradiation in glutaminic acid solution produces for both 248 and 193 nm a greater reduction of the contact-angle than the irradiation in water. The reduction for 193 nm is greater and could be reached with a lower dose of radiation. The modification increases with rising fluence till an optimum is reached (whicht is for $\lambda_L = 193 nm$ at a dose of about 10 - 100 J/cm²). The value of the contact-angle increases again for higher fluences and reaches lastly values lying near to values of the untreated sample. Samples being irradiated with such high doses show a discolouring to brown.

Spectroscopy Just a few significant differences between irradiated and unirradiated samples can be detected by transmission- and reflection-spectroscopy in both the IR- and the UV/VIS-region. Small differences between untreated and modified samples are visible in the IR-ATR-spectrum. Probably they are due to either crystallization or post-polymerisation. Modified samples show a distinct increased fluorescence-background in the Raman-spectrum, which doesn't show significant changes itself. The cause for this seems to be the formation of

Layerthickness radicals or double-bounds. From this it is concluded that the modified layer is just a fraction of a µm thick.

Mechanism A mechanism of modification is also discussed consisting of the reaction-steps: excitation and photolytic dissocation of water and glutaminic acid, defluorisation of poly(tetrafluorethylene) through the formed

hydrogen-radicals and the reaction of the remaining radicals at the poly(tetrafluorethylene)-chain with other radicals.