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NITROGEN RICH PLASMAPOLYMERS FOR BIOMEDICAL APPLICATIONS

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Low temperature plasmas nowadays found a broad field of applications, from technology to astrophysics. One rapidly developing area concerns biomedical applications. One direction in this field is the direct application of plasmas for e.g. sterilization processes [1, 2] or wound treatment [3]. The other concerns the use of plasma technology as an important tool for the production of polymers or for the modification of surface properties of synthetic polymers used for the control of bio-interfacial interactions. Nanoparticles, in particular, can adsorb biomolecules very strongly and play an important role in the immobilization of biomolecules due to their large specific surface area and high surface free energy. Nanoparticles and nanocomposite materials have therefore nowadays found an increasing number of applications in biomedical research [4-6]. They can be used for example for bioimaging in MRI and luminescence techniques, for drug delivery or as biomedical sensors.

An important class of polymer systems are nitrogen rich polymers. This group of polymers supports cell adhesion and is also used as chemically reactive platforms for the covalent immobilization of biologically active molecules [4]. With respect to biomedical applications, surface amine groups have been considered to be the essential feature of such polymer systems. These groups are chemically reactive and they are used for example in aqueous environments for covalent coupling of proteins. Another important functional group is the carboxyl group. Examples of bioactive molecules that have been successfully immobilized onto plasma-prepared amine groups are DNA, protein A, heparin or immunoglobulin [5].

Polymerisation reactions in low temperature plasmas in mixtures of hydrocarbons and nitrogen containing gases lead to the formation of nanoparticles with a nitrogen content up to 30 %. The synthesis of such kind of nanocomposites/nanoparticles and their analysis will be presented. The analysis is performed by XPS and NEXAFS measurements and by chemical methods as described e.g. in Ref. [7]. NEXAFS measurements clearly reveal the existence of amine groups on the surface of nanoparticles/nanocomposites. We analysed also the stability of the materials under the influence of atmospheric exposure, irradiation or temperatures changes.

The investigations on nanoparticle formation are closely related to fundamental plasma physical questions as for example: the fragmentation of the monomers, the formation of radicals in gas phase reactions, the impinging of ions onto the particles etc. All these parameter determine the final surface constitution of plasma synthesised nanoparticles. The plasma itself is therefore analyzed by means of mass spectrometry, optical emission spectroscopy, electrical characterization and laser light scattering.

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