

Composite materials made of electrospun polymer nanofibers coated by plasma-chemical deposited layers: Preparation and properties

KEDROŇOVÁ, Eva ^{1,2,3}; PŘÍHODA, Jiří ¹; ZAJÍČKOVÁ, Lenka ^{2,3}; HEGEMANN, Dirk ⁴; MANAKHOV, Anton ^{3,5}; KLÍMA, Miloš ^{2,3}; KUPKA, Vojtěch ⁶; MICHLÍČEK, Miroslav ^{2,3}

¹ Department of Chemistry, Faculty of Science, Masaryk University Brno, Czech Republic

² Department of Physical Electronics, Faculty of Science, Masaryk University Brno, Czech Republic

³ Plasma Technologies, CEITEC MU, Brno, Czech Republic

⁴ EMPA St. Gallen, Switzerland

⁵ National University of Science and Technology MISIS, Moscow, Russia

⁶ Advanced Polymers and Composites, CEITEC BUT, Brno, Czech Republic

Electrospinning is commonly used for preparation of nanofibers from numerous polymers. For particular application of the nanofibrous meshes there is a necessity of additional surface treatment, in order to obtain required functional properties of resulting composite materials. For this process, plasma chemical deposition from gas phase can be advantageous. Plasma enhanced chemical vapor deposition (PECVD) is a versatile technique used for surface modification and is suitable also for highly porous and temperature-sensitive materials such as electrospun nanofibers. Several combinations of electrospun nanofibers and plasma-chemical coatings were tested. First of all, organosilicon plasma polymers were deposited on PVA and PA6 electrospun nanofibers from HMDSO/Ar mixtures. The organosilicon layer is supposed to increase the hydrophobicity of the resulting nanofibrous meshes. Low pressure RF discharges with capacitive coupling and cold RF plasma multi-jet working at atmospheric pressure were used for the depositions and the process conditions were varied in order to get samples with different structure and wettability. The influence of deposition conditions on chemical composition of the resulting layers was investigated by IR spectroscopy and the XPS. The values of the WCA were strongly dependent on both, chemical composition of deposited layers and overall surface structure. Significant variation in microstructure of obtained composites were revealed by AFM and SEM analysis of materials prepared by different plasma sources. The other type of investigated composites was composed of electrospun PCL/PEG nanofibers prepared by electrospinning of the solutions containing various ratios of PCL:PEG polymers ranging from 5:95 to 75:25. The optimization of PCL/PEG ratio, polymer concentration and electrospinning conditions (e.g. voltage, electrodes distance) leads the changes in substrate morphology, homogeneity and fiber thickness. The PCL:PEG ratio also influenced the degradability and the mechanical properties of nanofibers. In order to improve the wettability of the nanofibers a thin amine layer by means of cyclopropylamine plasma polymerization in RF capacitively coupled discharge was deposited. The properties of the coated nanofibrous meshes were studied by XPS, IR spectroscopy and SEM. The presence of the amine groups enhanced the adhesion and proliferation of the cells, thus favors the properties of nanofibers for biomedical application. The obtained results prove the high potential and variability of composite materials prepared by plasma-coated electrospun meshes.