ABSTRACT

The present diploma thesis deals with the development of biodegradable polymer nanofibrous scaffolds with Electrospray Deposition Method and the fabrication of thin films with Spin Coating Method within the framework of Regenerative Medicine and especially Tissue Engineering Applications. The ultimate goal was to create a biomimetic nanofibrous environment that simulates the extracellular matrix (ECM) of articular cartilage and thus promotes the adhesion and proliferation of chondrocytes. Poly-caprolactone (PCL), a synthetic polymer and Chitosan, a natural polymer were chosen for this study. Also, Chi/PCL copolymers in different ratios (80:20, 65:35, 50:50) were prepared. Various polymer solutions in different concentrations and solvents were tested in order to find the optimal solution for the fabrication of each polymer scaffold. It was found that a necessary condition for the creation of copolymer scaffolds is the use of a common solvent (Trifluoroacetic acid/Dichloromethane TFA/DCM 80:20) within the optimal concentrations of individual polymers and optimal ratio was found to be 50:50. On the contrary, a common solvent was used for thin films so as to be comparable between them. The structural/morphological/topographic characterization of scaffolds and thin films was conducted with Scanning Electron Microscope (SEM) and Atomic Force Microscopy (AFM) and Contact angle (CA) measurements were performed for wettability tests. PCL samples had a hydrophobic behavior, especially scaffolds, whereas, Chitosan was hydrophilic. The chemical nature of the thin films was evaluated by Raman spectroscopy. The Raman spectrum of the copolymer resulted from the contribution of the individual spectra of the two polymers, which verifies the presence of the two polymers in the copolymer, although there was phase separation in the solutions. The scaffolds and thin films were also studied for their biocompatibility with cell lines, particularly, L929s cells and human chondrocytes for three intervals (24hrs, 3 days, 7 days). MTT assay was performed for the quantitative assessment of the cell-seeded scaffolds and thin films. To complete the cell studies, images were obtained by Scanning Electron Microscopy (SEM) and optical microscopy after staining with methylene blue. PCL in the group of thin films showed the highest cell viability, whereas, PCL nanofibrous scaffold the lowest. Chitosan in the group of nanofibrous scaffolds was the most favorable to cell proliferation.

Chitosan/PCL co-polymer exhibited an intermediated cellular behavior. In nanofibrous polymeric scaffolds, natural polymers such as chitosan, show greater biocompatibility, since they are consisted of cell-recognized components. It seems that the main mechanism of cell adhesion includes direct fiber - cells interactions because of the roughness and increased available area (ratio of surface area / volume). It was concluded that surface chemical composition, roughness, wettability and topography are crucial factors, by determining biocompatibility of a polymeric material, since they govern the mechanism of cellular adhesion and impact cellular growth, proliferation, immigration.