List of Tables

Table	Caption	Page No.
Chapter I		
Table 1.1	Key properties of some commonly used CPs including MEH-PPV and their limitations including their major biomedical applications.	46
Chapter III		
Table 3.1	Some physical properties of materials used in the synthesis and surface functionalization of PAni nanofibers and PAni:Ch nanocomposites.	80
Table 3.2	Some physical properties of MEH-PPV used in electrospinning of MEH-PPV:PCL nanofibers.	81
Chapter IV		
Table 4.1	Characteristics of the X-ray diffraction peaks of PNFs and SF-PNFs corresponding to (100) and (110) reflections.	123
Table 4.2	Calculated sheet resistance (R_s) and critical voltage (V_c) values of PAni nanofibers (PNFs) before and after surface functionalization by glutaraldehyde.	126
Table 4.3	Fitting parameters to *Kaiser Equation* for PNFs and SF-PNFs.	127
Table 4.4	Average contact angle values ± S.D. of water, ethylene glycol and diiodomethane on pristine and surface functionalized PAni films.	140
Table 4.5	Surface energy and its components calculated by the OWRK method taking water and diiodomethane as probe liquids. Data are Mean ± S.D.	141
Table 4.6	Surface energy and its components calculated by AB method taking water, ethylene glycol and diiodomethane probe liquids. Data are Mean ± S.D.	141

Table 4.7 FRET Efficiency (E_{FRET}) of SF-PNFs with different concentrations of Tyrosine, Tryptophan, and Phenylalanine. Data are Mean ± S.D. 156

Chapter V

Table 5.1 Degree of crystallinity of pure Ch, PAni nanofibers (PNFs) and PAni:Ch nanocomposites with 4 wt% and 6 wt% PAni content. 174

Table 5.2 Calculated sheet resistance (R_s) and critical voltage (V_c) values of the different PAni:Ch nanocomposites films before and after surface functionalization. Sheet resistance (R_s) data were expressed as Mean ± S.D (n=3). 176

Table 5.3 Sheet resistance (R_s), and percentage of weight loss of the non-functionalized and functionalized PAni:Ch nanocomposites after 15 days in PBS (pH=7.4). 180

Table 5.4 Major thermal degradation temperatures and corresponding weight loss of the non-functionalized and functionalized nanocomposites. 182

Table 5.5 Elemental composition of non-functionalized and glutaraldehyde functionalized PAni:Ch nanocomposites determined by XPS survey scans. 185

Table 5.6 Details of C1s narrow scan spectra of PAni:Ch-4 wt% and GFPAni:Ch-4 wt% corresponding C1s peak deconvolution [366, 399, 400]. 186

Table 5.7 Elemental composition of non-functionalized and glycine NHS ester functionalized PAni:Ch nanocomposites determined by XPS survey scans. 189

Table 5.8 Details of C1s narrow scan spectra of PAni:Ch-4 wt%and EFPAni:Ch-4 wt% and their corresponding C1s peak deconvolutions [366, 399, 400]. 189

Table 5.9 Average contact angle values for PAni:Ch nanocomposite films before and after surface modification (n = 3, mean ± SD). 193

Table 5.10 Surface energy and its components calculated by the OWRK method taking water and diiodomethane as probe liquids. 193

Table 5.11 Surface energy and its components calculated by AB method taking water, ethylene glycol and diiodomethane probe liquids. 194

Chapter VI

Table 6.1 Characteristics of the X-ray diffraction peaks of blended MEH-PPV:PCL nanofibers and core-sheath MEH-PPV:PCL nanofibers corresponding to (110) and (200) reflections. 235

Table 6.2 Major thermal degradation temperatures and corresponding weight loss of the blended and core-sheath MEH-PPV:PCL nanofibers. 236

Table 6.3 Calculated sheet resistance *(R_s)* values of the different electrospun meshes prepared by simple electrospinning and coaxial electrospinning process. Sheet resistance *(R_s)* data were expressed as Mean ± S.D (n=3). 240

Table 6.4 Fitting parameters to *Kaiser equation* for blended MEH-PPV:PCL nanofibers and core-sheath MEH-PPV:PCL nanofibers before and after surface functionalization by APTES and 1,6-Hexanediamine. 243

Table 6.5 Fiber diameters, sheet Resistance (R_s), and percentage of weight loss of the different blended MEH-PPV:PCL electrospun nanofibers and core-sheath MEH-PPV:PCL nanofibers before and after 45 days of incubation in PBS (pH=7.4). 249

Table 6.6 Elemental composition of non-functionalized and functionalized blended MEH-PPV:PCL electrospun nanofibers determined by XPS survey scans. 255

Table 6.7 Details of peak deconvolution of C1s narrow scan spectra of SEN1, AFSEN1, and HFSEN1. 255

Table 6.8 Elemental composition of non-functionalized and 257

functionalized core-sheath MEH-PPV:PCL electrospun nanofibers determined by XPS survey scans.

Table 6.9 Details of peak deconvolution of C1s narrow scan spectra of CSN1, AFCSN1, and HFCSN1. 257

List of Figures

Figure	Caption	Page No.
Chapter I		
Figure 1.1	Molecular structures of some of the widely used conducting polymers (CPs).	2
Figure 1.2	Schematic illustration of the formation of σ and π molecular orbitals from two sp^2 hybridized carbon atoms in conducting polymers.	3
Figure 1.3	Scheme of HOMO and LUMO band formation in conducting polymers (CPs).	5
Figure 1.4	Schematic representation of band structure of CPs after the formation of localized defects (charge carriers) viz., polaron, bipolaron, soliton and defect band upon doping.	6
Figure 1.5	Formation of polaron and solitons in *trans*-PA (a) neutral chain, (b) polaron and (c) soliton. (d) Schematic illustration of the modifications in the band structure of *trans*-PA after the creation of neutral, positively charged and negatively charged soliton upon doping.	7
Figure 1.6	Phase transition of localized bipolaron to ordered polaron lattice in PAni. Formation of (a) bipolaron, (b) two polarons (after disassociation of bipolaron) and (c) polaron lattice in PAni. (d) Schematic illustration of energy levels of neutral polymer, positive polaron, bipolaron, and polaron pair of PAni.	8
Figure 1.7	Formation of localized defects in MEH-PPV: (a) neutral chain, (b) polaron and (c) bipolaron, (d) Schematic illustration in the band modifications of MEH-PPV upon formation of localized defects, i.e., polaron and bipolaron.	9
Figure 1.8	Generalized molecular structure of PAni along with	10

typical intrinsic oxidation states of PAni viz. leucoemeraldine (LEB), protoemeradine (PEB), nigraniline (NA), emeraldine (EB), and pernigraniline (PNB).

Figure 1.9 Molecular structure of PPV and its various alkoxy-substituted derivatives in increasing order of their solubility. 12

Figure 1.10 Principle of tissue engineering. General process of tissue engineering involves seed cells on biomaterial scaffold, culturing *in vitro* and implant into the patient showing the necessary characteristics that an ideal scaffold should possess. 14

Figure 1.11 Biomedical applications of CPs. 17

Figure 1.12 Various parameters and factors in fabrication of electrically conductive CP based biomaterials. 27

Figure 1.13 Common modification strategies of CPs for biomedical applications: (a) physical adsorption, (b) entrapping, (c) covalent modification and (d) exploiting the doping mechanism. 33

Figure 1.14 Schematic representation of surface functionalization of CP based biomaterials through incorporation of polar functionalities such carboxyl (-COOH), amine (-NH_2), aldehyde (-CHO), hydroxyl (-OH) etc. for favorable cell-biomaterial interaction. 35

Figure 1.15 Statistics on the literature published on (a) CPs in tissue engineering applications and (b) CP based biomaterials for electrical stimulation during the period 1993-2017(search made through Web of Science using as keywords: (a) Conducting polymers + Tissue engineering and (d) Electrical stimulation + Conducting polymers). 42

Chapter II

Figure 2.1 Mechanism of chemical polymerization of aniline in 54

presence of oxidant ammonium persulfate, $(NH_4)_2S_2O_8$ as proposed by Epstein *et al* [269].

Figure 2.2 Schematic representation of the growth and elongation of an initially formed nanofiber. 55

Figure 2.3 Single heterogeneous nucleation mechanism of PAni nanofiber formation according to Chiou *et al* [267]. 56

Figure 2.4 Schematic illustration of interfacial polymerization process in a aqueous/organic biphasic solution. The top layer is an aqueous solution consisting of dopant and oxidant, whereas the bottom layer is monomer solution in organic solvent. 58

Figure 2.5 Schematic representation of electrospinning process to produce o nanofibers from a polymer solution using syringe and high voltage power supply showing the formation of Taylor cone and subsequent generation of polymer jet deposited on the collector. 59

Figure 2.6 Schematic diagram illustrating charge generation and transport during electrospinning. 61

Figure 2.7 Jablonski diagram illustrating the FRET process. 66

Figure 2.8 Absorption and fluorescence spectra of an ideal donor-acceptor pair showing the spectral overlap between the fluorescence spectrum of donor and absorption spectrum of acceptor. 68

Figure 2.9 The effect of substrate concentration on the rate of an enzyme-catalyzed reaction. 74

Chapter III

Figure 3.1 Images illustrating dilute polymerization of polyaniline (PAni) nanofibers. 82

Figure 3.2 Schematic representation of surface functionalization of polyaniline (PAni) nanofibers by glutaraldehyde. 83

Figure 3.3. Percentage of cell viability of PBMC for 1% glutaraldehyde solution at three different doses. As the concentration of the doses increases, percentage of cell 84

viability observed to be decreased. It indicates the biocompatibility nature of glutaraldehyde at lower dose level.

Figure 3.4 Schematic representation of synthesis of and polyaniline (PAni) nanofibers and polyaniline nanofibers:chitosan (PAni:Ch) nanocomposites. 84

Figure 3.5 Schematic representation of the surface functionalization of polyaniline nanofibers:chitosan (PAni:Ch) nanocomposites using BOC glycine-NHS ester. 85

Figure 3.6 Schematic representations showing electrospinning of MEH-PPV:PCL by (a) simple electrospinning process and (b) coaxial electrospinning process. 87

Figure 3.7 Photograph of coaxial electrospinning of MEH-PPV:PCL nanofibers. 89

Figure 3.8 (a) Typical X-ray diffractogram of a semi-crystalline polymer and (b) XRD patterns showing the superposition of crystalline peaks and an amorphous hump. 97

Figure 3.9 An example of a photoelectron emitted due an incident photon. 101

Figure 3.10 (a) Schematic illustration of the electrical stimulation experiment using a custom made electrical stimulation set up ; (b) photograph of self made cell culture plate with different CP based scaffolds fixed on it for electrical stimulation experiment; (c) photograph of the electrical stimulation experiment in situ. 114

Chapter IV

Figure 4.1 Schematic illustration of synthesis of PAni nanofibers (PNFs) by the dilute polymerization technique and surface functionalization by glutaraldehyde for enhanced fluorescence signals in presence of aromatic amino acids (Tyr, Trp and Phe) and for enhanced MDA- 120

MB-231 cell adhesion, spreading and proliferation.

Figure 4.2 Transmission electron micrograph of PAni nanofibers synthesized by dilute polymerization technique. Inset shows the SAED pattern of PAni nanofibers. 121

Figure 4.3 Scanning electron micrograph of PAni nanofibers in (a) powder form and (b) film form. 122

Figure 4.4 X-ray diffraction patterns of PNFs (black) and SF-PNFs (red). Inset shows a Voigtian fit of the x-ray profile that best describes the x-ray pattern for (a) PNFs and (b) SF-PNFs. 122

Figure 4.5 Room temperature (300 K) *I-V* characteristics of PNFs and SF-PNFs. 124

Figure 4.6 Plots of forward I-V data on a log-log scale for (a) PNFs, and (b) SF-PNFs. 124

Figure 4.7 Positive sides of *I-V* characteristics of PNFs and SF-PNFs fitted with *Kaiser Equation*. 127

Figure 4.8 (a) Stress *vs* Strain curve of PAni film prepared in NMP before and after surface functionalization; (b) Comparison of Young Modulus or stiffness constant (*E*) and ultimate tensile strength (UTS) of PNFS and SF-PNFs. Data were expressed as Mean ± S.D (n=3). 128

Figure 4.9 Scanning electron micrographs of (a) PNFs, and (b) SF-PNFs recorded after keeping in PBS (pH=7.4) for 30 days (Scale bar = 500 nm). 128

Figure 4.10 **(**a) TGA thermograms and (b) DTG plots of PNFs and SF-PNFs. 129

Figure 4.11 Vibrational spectra of PNFs (black) and SF-PNFs (red) showing incorporation of polar functional hydroxyl (-OH) and aldehyde (-CHO) groups. 130

Figure 4.12 ^{1}H NMR spectrum showing the characteristics peaks of PNFs. Observed peaks are assigned by labelling the various protons in different chemical environment in predicted chemical structure of the polymer. 132

Figure 4.13	^{1}H NMR spectrum of SF-PNFs showing the chemical shift value after incorporation of hydroxyl (-OH) and aldehyde (-CHO) functional groups. Observed peaks are assigned by labelling with the help of predicted chemical structure of the polymer.	133
Figure 4.14	(a) UV-visible absorption spectra (b) emission spectra of PNFs and SF-PNFs in 0.1M PBS at p^{H}=7.4 (λ_{ex}=280 nm).	134
Figure 4.15	Scheme of possible functionalization mechanisms of PNFs by three different forms of glutaraldehyde showing quinoid to benzenoid transformation in the polymer chain.	138
Figure 4.16	Representative images of contact angle measurement using three different liquids (water and ethylene glycol as polar liquids and diiodomethane as non polar liquid) on film of PNFs and SF-PNFs.	140
Figure 4.17	(a) UV-Visible absorption spectra and (b) Fluorescence spectra of SF-PNFs before and after exposure to aromatic amino acids Tyrosine (S1), Tryptophan (S2), Phenylalanine (S3), Proline (S4) and Histidine (S5) in PBS at p^{H} = 7.4.	143
Figure 4.18	Chemical structure of five aromatic amino acids classified in accordance with their contributions to fluorescence enhancement of SF-PNFs.	144
Figure 4.19	Overlapping of absorption spectrum of SF-PNFs (acceptor) with emission spectrum of (d) Tyrosine (donor), (e) Tryptophan (donor) and (f) Phenylalanine (donor) in PBS at p^{H} = 7.4.	145
Figure 4.20	Fluorescence spectra of SF-PNFs, Tyrosine, Tryptophan, and Phenylalanine in PBS at P^{H} = 7.4 at an excitation wavelength λ_{ex}= 250 nm.	145
Figure 4.21	Vibrational spectra of PNFs, SF-PNFs and SF-PNFs before and after exposure to Tyrosine (S1), Tryptophan	147

(S2) and Phenylalanine (S3) indicating different covalent interactions between the amino acids and SF-PNFs.

Figure 4.22 ^{1}H NMR spectrum of SF-PNFs in presence of Tyrosine (S1) in DMSO. Observed peaks are assigned by labelling with the help of predicted chemical structure of the polymer amino acid complex. 149

Figure 4.23 ^{1}H NMR spectrum of surface functionalized PAni nanofibers (SF-PNFs) in presence of Tryptophan (S2) in DMSO. Observed peaks are assigned by labelling with the help of predicted chemical structure of the polymer amino acid complex. 150

Figure 4.24 ^{1}H NMR spectrum of surface functionalized PAni nanofibers (SF-PNFs) in presence of Phenylalanine (S3) in DMSO. Observed peaks are assigned by labelling with the help of predicted chemical structure of the polymer amino acid complex. 151

Figure 4.25 Predicted covalent interaction mechanisms between SF-PNFs and Tyrosine (Scheme I), SF-PNFs and Tryptophan (Scheme II) and SF-PNFs and Phenylalanine (Scheme III) based on FT-IR and ^{1}H NMR results. 153

Figure 4.26 Fluorescence response of SF-PNFs when exposed to different concentrations of (a) Tyrosine, (b) Tryptophan and (c) Phenylalanine in PBS at p^{H} = 7.4. The double reciprocal curves for the interaction between SF-PNFs with (d) Tyrosine (n=2, Adj. R-square = 0.9966), (e) Tryptophan (n=2, Adj. R-square = 0.9886) and (f) Phenylalanine (n=2, Adj. R-square = 0.9873). 154

Figure 4.27 Fluorescence micrographs of (a) SF-PNFs before and after exposure to (b)Tyrosine, (b) Tryptophan and (c) Phenylalanine under illumination of 365 nm light acquired by Fluorescence microscope model Leica DM 155

300.

Figure 4.28 Comparative interference studies using different amino acids with both PNFs and SF-PNFs in PBS at p^H = 7.4. The concentration of PNFs and SF-PNFs kept fixed throughout the experiment, while the concentration of all the amino acids is taken as 30 mM. 157

Figure 4.29 Hemolysis activity of PNFs and SF-PNFs in terms of percentage of hemolysis in PBS at p^H=7.4 showing a comparison of hemolysis activity of drug ascorbic acid. Data are expressed as means ± SD, n=3; **: P≤0.001, values are significantly different from those obtained with +ve control. 158

Figure 4.30 Percentage of MDA-MB-231 cell viability on films of PNFs and SF-PNFs in direct contact after 24 h of culture as compared to tissue culture plastic (TCP) as a negative control and tert butyl maleate as a positive control. Data were Mean ± S.D, n=3.*≤0.05. 159

Figure 4.31 Acridine orange/ethidium bromide (AO/EtBr) stained fluorescence images of MDA-MB-231 cells cultured for 48 h on (a) glass cover slip, (b) PNFs and (c) SF-PNFs (Scale bar = 75μm). 160

Figure 4.32 Quantitative analysis of (a) cell density per 780 μm^2 area,(b) projected cell area and (c) percent of cell spreading, derived from the AO/EtBr stained fluorescence images of MDA-MB-231 cells after 48 h of culture. Data were expressed as Mean ± S.D, n=6.*indicates statistically significance difference at ≤0.05. 161

Figure 4.33 Scanning electron micrographs of MDA-MB-231 cells on PNFs (a1 & a2) and SF-PNFs (b1 & b2) after 48 h of culture at lower magnification (a1: 500X, b1:300X) and higher magnification (b1 & b2: 900X). 163

Chapter V

Figure 5.1 Schematic illustration of incorporation of polar functional groups (carboxyl and amine) by surface functionalization of PAni:Ch nanocomposites for improved 3T3 cell adhesion, spreading and proliferation. Electrical stimulation of PC12 cells through collagen coated PAni:Ch nanocomposites for enhanced neurite outgrowth. 171

Figure 5.2 Scanning electron micrographs of (a) powdered PAni nanofibers, (b) Ch and PAni:Ch nanocomposites with (c) 4 wt% and (d) 6wt% of PAni content. 172

Figure 5.3 (a) X-ray diffraction patterns of pure Ch and PAni nanofibers as labeled; (b) X-ray diffraction patterns of PAni:Ch nanocomposites with 4 wt% and 6 wt% of PAni content as labeled. 173

Figure 5.4 Room temperature (300 K)*I-V* characteristics of (a) GFPAni:Ch-4 wt% (red), (b) GFPAni:Ch-6 wt% (red), (c) EFPAni:Ch-4 wt% (red) and (d) EFPAni:Ch-6 wt% (red) with comparison to their non-functionalized counterparts (black). 175

Figure 5.5 Plots of forward I-V data on a log-log scale for (a) PAni:Ch-4 wt%, (b) PAni:Ch-6 wt%, (c) GFPAni:Ch-4 wt%, (d) GFPAni:Ch-6 wt%, (e) EFPAni:Ch-4wt%, and (f) EFPAni:Ch-6 wt%. 177

Figure 5.6 **(**a) Stress *vs* Strain curve and (b) comparison of Young Modulus or stiffness constant (*E*) and ultimate tensile strength (UTS) of PAni:Ch nanocomposites before and after surface functionalization. Data were expressed as Mean ± S.D (n=3). 178

Figure 5.7 Scanning electron micrographs of (a) PAni:Ch-4 wt%, (b) PAni:Ch-6 wt%, (c) GFPAni:Ch-4 wt%, (d) GFPAni:Ch-6 wt%, (e) EFPAni:Ch-4 wt% and (f) EFPAni:Ch-6wt%recorded after keeping in PBS 180

(pH=7.4) for 15 days (Scale bar = 200 nm).

Figure 5.8 (a) TGA thermograms and (b) DTG plots of different PAni:Ch nanocomposites as labeled. 181

Figure 5.9 Vibrational spectra of PAni nanofibers (black) and pure Ch (red). 183

Figure 5.10 (a) Vibrational spectra of PAni:Ch nanocomposites before and after surface functionalization by glutaraldehyde; (b) elemental composition PAni:Ch nanocomposites before and after functionalization with glutaraldehyde. Peak deconvolutions of high-resolution C1s XPS spectra of (c) PAni:Ch-4 wt% and (d) GFPAni:Ch-4 wt%. 184

Figure 5.11 Probable interaction mechanisms of glutaraldehyde with PAni:Ch nanocomposites based on XPS and FTIR results. 187

Figure 5.12 (a) Vibrational spectra of PAni:Ch nanocomposites and (b) elemental composition PAni:Ch nanocomposites before and after surface functionalization by glycine NHS ester. Peak deconvolutions of high-resolution C1s XPS spectra of (c) PAni:Ch-4 wt% and (d) EFPAni:Ch-4 wt%. 188

Figure 5.13 Probable interaction mechanisms of glycine NHS ester with PAni:Ch nanocomposites based on XPS and FTIR results. 190

Figure 5.14 Representative contact angle images of using three probe liquids on PAni:Ch-4 wt% (a1:water; c1:ethylene glycol; e1:diiodomethane), PAni:Ch-6 wt% (b1:water; d1:ethylene glycol; f1:diiodomethane), GFPAni:Ch-4 wt% (a2:water; c2:ethylene glycol; e2:diiodomethane), GFPAni:Ch-6 wt% (b2:water; d2:ethylene glycol; f2:diiodomethane), EFPAni:Ch-4 wt% (a3:water; c3:ethylene glycol; e3:diiodomethane) and EFPAni:Ch-6 wt% (b3:water; d3:ethylene glycol; 192

f3:diiodomethane).

Figure 5.15 Calibration curve to determine the slope. Slope is 0.00125 mM^{-1} i.e., 3.0 × 10^{-3} μmol^{-1} (Since the total volume of the solution is 2 mL). 198

Figure 5.16 (a) Activity of free urease and immoblized urease on non-functionalized and glutaraldehyde functionalized PAni:Ch nanocomposites at room temperature (p^H = 7.4). (b) pH stability of the activity of free urease and immoblized urease on non-functionalized and glutaraldehyde functionalized PAni:Ch nanocomposites. 199

Figure 5.17 Reusability of urease immobilized non-functionalized and glutaraldehyde functionalized PAni:Ch nanocomposites at room temperature (pH=7.4). 201

Figure 5.18 Lineweaver-Burk plots of free urease, immobilized urease on non-functionalized and glutaraldehyde functionalized PAni:Ch nanocomposites. Reactions were carried out in PBS (pH=7.4) at room temperature. 202

Figure 5.19 Percentage hemolysis (Mean ± S.D, n=4) shown by the non-functionalized and functionalized PAni:Ch nanocomposites as compared to negative control (Phosphate buffer saline, pH= 7.4) and positive control (Triton X 100). Inset shows photographs of RBC treatment with different materials as labeled. 204

Figure 5.20 Percentage of MDA-MB-231 cell viability on the non-functionalized and glutaraldehyde functionalized PAni:Ch nanocomposites in direct contact after 24 h of culture as compared to tissue culture plastic (TCP) as a negative control and *tert* butyl maleate as a positive control. Data were Mean ± S.D, n=3. $^{*}\leq 0.05$. 205

Figure 5.21 Fluorescence micrographs of AO/EtBr stained MDA-MB-231 cells on (a) PAni:Ch-4 wt%, (b) PAni:Ch-6 wt%, (c) GFPAni:Ch-4 wt% and (d) GFPAni:Ch-6 wt% after 48 h of culture. 207

Figure 5.22 Quantitative analysis of (a) cell counts, (b) percentage of cell spreading and (c) area per cell on non-functionalized and functionalized PAni:Ch nanocomposites after 48 h of culture. Data were Mean ± S.D., n=3.[#] and [*] indicate the statistical significance at $p \leq 0.01$ and $p \leq 0.05$, respectively. 207

Figure 5.23 Scanning electron micrograph of MDA-MB-231 cells cultured on (a) PAni:Ch-4 wt% (Scale bar= 50 μm), (b) PAni:Ch-6 wt% (Scale bar= 20 μm), (c) GFPAni:Ch-4 wt% (Scale bar= 50 μm) and (d) GFPAni:Ch-6 wt% (Scale bar=20 μm) after 48 h. 209

Figure 5.24 Percentage hemolysis (n = 4, mean ± S.D) shown by the non-functionalized and glycine NHS ester functionalized PAni:Ch nanocomposites as compared to negative control (Phosphate buffer saline, pH= 7.4) and positive control (Triton X 100). Inset shows photographs of RBC treatment with different materials as labeled. 210

Figure 5.25 Percentage cell viability after 24 h of culture on glycine NHS ester functionalizednanocomposites compared to non-functionalized nanocomposites, raw materials (n=4, mean ± SD) with (a) 3T3 fibroblasts and (b) PC12 cells. *Significant differences between negative control and test materials at $p<0.05$; #Significant differences between unmodified nanocomposites and modified nanocomposites at $p<0.05$. 211

Figure 5.26 Confocal images of 3T3 fibroblasts after 24 h of culture on pure tissue culture plastic (a1-a4), Ch (b1-b4), PAni:Ch-4 wt% (c1-c2), PAni:Ch-6 wt% (d1-d4), EFPAni:Ch-4 wt% (e1-e4) and EFPAni:Ch-6 wt% (f1-f4) in direct contact by live/dead staining using EthD-1 (staining dead cells), calcein AM (staining live cells) and DAPI (staining nucleic acid). Live cells were 212

stained with green, dead cells were stained with red, and nucleic acids were stained with blue. (Scale bar = 75 μm).

Figure 5.27 **(**a) Representative confocal images of calcein AM stained viable cells seeded on different scaffolds (labeled in the photographs) for 24 h and 48 h, used for analysis of cell morphology(Scale bar = 75 μm). (b) Histogram showing area covered by single cell on different scaffolds after 24 h and 48 h. c. Histogram of percent of cell spreading on different scaffolds after 24 h and 48 h. *indicates significant differences between the non-functionalized and functionalized nanocomposites at $p \leq 0.05$. 214

Figure 5.28 SEM images of 3T3 cells cultured for 3 days on the non-functionalized (a) PAni:Ch-4 wt%, (b) PAni:Ch-6 wt% and glycine NHS ester functionalized (c) EFPAni:Ch-4 wt% and (d) EFPAni:Ch-6 wt%.(Scale bar = 20 μm) 215

Figure 5.29 Beta (III) tubulin immunostaining of PC12 cells cultured for 7 days on non-functionalized PAni:Ch-4 wt% (a1) and PAni:Ch-6 wt% (b1), EFPAni:Ch-4 wt% (a2), EFPAni:Ch-6 wt% (b2) and collagen I coated PAni:Ch-4 wt% (a3) and PAni:Ch-6 wt% (b3) [Scale bar = 75 μm]. Inset of a1 shows the immnulabelling of PC12 cells cultured on collagen coated glass cover slip. Quantitative analysis of differentiated PC12 cells: (c) % neurite bearing cells and (d)avg. neurite length per cell. 217

Figure 5.30 Scanning electron micrographs of PC12 cells after 7 days of culture on collagen coated (a) PAni:Ch- 4wt% and (b) PAni:Ch- 6wt%. Red arrows point to the neurite projection. Scale bar = 5 μm 218

Figure 5.31 (a) Schematic illustration of the electrical stimulation experiment using a custom made electrical stimulation 219

set up; (b) photograph of self made cell culture plate with PAni:Ch nanocomposites with 4 wt% and 6 wt% PAni content (dark blue colur) fixed on it for electrical stimulation experiment; (c) photograph of the electrical stimulation experiment in situ.

Figure 5.32 Current signal recorded (upto 50 s) during electrical stimulation of PC12 cells through conductive PAni:Ch nanocomposites through (a) collagen coated PAni:Ch-4 wt% and (b) collagen coated PAni:Ch-6 wt%. A constant potential of 500 mV/cm for 2 h was applied in chronoamperometric technique in pulsed mode (pulse duration 1 ms). 220

Figure 5.33 Confocal images with phase contrast overlay of beta (III) tubulin immunostained PC12 cells cultured for 7 days under no electrical stimulation (a1-collagen coated PAni:Ch-4 wt%, b1-collagen coated PAni:Ch-6 wt%) and under electrical stimulation of 500 mV/cm for 2h/day for 3 cosecutive days (a2-collagen coated PAni:Ch-4 wt%, b2-collagen coated PAni:Ch-6 wt%) [Scale bar = 75 μm]; (c) Percentage of neurite bearing cells, (d) Neurite length per cell, (e) Median neurite length and (f) Neurite per cell of differentiated PC12 cells on collagen coated PAni:Ch nanocomposites without electrical stimulation and with electrical stimulation. Data were Mean ± S.D. *indicates statistical significance difference from unstimulated PC12 cells at $p \leq 0.05$. 222

Chapter VI

Figure 6.1 Schematic illustration of simple and coaxial electrospinning of MEH-PPV:PCL nanofibers in blended form and core-sheath morphology along surface amination by post-surface functionalization by APTES and 1,6-hexanediamine for 3T3 fibroblasts adhesion and 230

spreading and neuronal growth of differentiated PC12 cells under electrical stimulation.

Figure 6.2 Scanning electron micrographs of electrospun nanofibers prepared by simple electrospinning of blend of MEH-PPV and PCL at various volume ratios. a1 & a2: SEN1 (20:80), b1 & b2: SEN2 (40:60), c1 & c2: SEN3 (50:50) and d1 & d2: SEN4 (60:40). Suffix '1' and '2' stand for magnification at 5 K and 50 K, respectively. Scale bar: 4 μm (a1, b1, c1 & d1) and 400 nm (a2, b2, c2 & d2). 231

Figure 6.3 Scanning electron micrographs of CSN1 (a1 & a2) and CSN2 (b1 & b2), acquired at two different magnifications of 5 K and 50 K. Transmission electron micrographs of CSN1 (c1) and CSN2 (c2) showing the formation of nanofibers with core-sheath morphology. Scale bar = 4 μm (a1 & b1), 300 nm (a2 & b2) and 500 nm (c1 & c2). 232

Figure 6.4 X-ray diffraction patterns of (a) SEN1, (b) SEN2, (c) SEN3 and (d) SEN4 as labeled along with a Voigtian fit of the x-ray profile that best describes the x-ray pattern of the blended electrospun nanofibers of MEH-PPV and PCL. 234

Figure 6.5 X-ray diffraction patterns of (a) CSN1 and (b) CSN2 as labeled along with a Voigtian fit of the x-ray profile that best describes the x-ray pattern of the core-sheath electrospun nanofibers. 234

Figure 6.6 (a) TGA thermograms and (b) DTG plots of blended and core-sheath MEH-PPV:PCL nanofibers. 235

Figure 6.7 Room temperature (300 K) *I-V* characteristics of (a) blended MEH-PPV:PCL nanofibers and (b) core-sheath MEH-PPV:PCL nanofibers. 237

Figure 6.8 Plots of forward *I-V* data on a log-log scale for (a1) SEN1, (b1) SEN2, (c1) SEN3, (d1) SEN4, (a2) 241

AFSEN1, (b2) AFSEN2, (c2) AFSEN3, (d2) AFSEN4, (a3) HFSEN1, (b3) HFSEN2, (c3) HFSEN3, and (d3) HFSEN4 at room temperature (300 K) showing the fitting parameters.

Figure 6.9 Plots of forward *I-V* data on a log-log scale for (a1) CSN1, (a2) AFCSN1, (a3) HFCSN1, (b1) CSN2, (b2) AFCSN2, and (b3) HFCSN2 at room temperature (300 K) showing the fitting parameters. 241

Figure 6.10 Positive sides of *I-V* characteristics of (a) non-functionalized and functionalized blended MEH-PPV:PCL nanofibers and (b) non-functionalized and functionalized core-sheath MEH-PPV:PCL nanofibers fitted with *Kaiser Equation*. 242

Figure 6.11 **(**a) Stress *vs* Strain curve and (b) comparison of Young Modulus or stiffness constant (*E*) and ultimate tensile strength (UTS) of blended MEH-PPV:PCL nanofibers prepared by simple electrospinning process before and after surface functionalization. Data were expressed as Mean ± S.D (n=3). 244

Figure 6.12 (a) Stress *vs* Strain curve and (b) comparison of Young Modulus or stiffness constant (*E*) and ultimate tensile strength (UTS) of the core-sheath MEH-PPV:PCL nanofibers prepared by coaxial electrospinning process before and after surface functionalization. Data were expressed as Mean ± S.D (n=3). 245

Figure 6.13 Scanning electron micrographs of (a1) SEN1, (a2) AFSEN1, (a3) HFSEN1, (b1) SEN2, (b2) AFSEN2, (b3) HFSEN2, (c1) SEN3, (c2) AFSEN3, (c3) HFSEN3, (d1) SEN4, (d2) AFSEN4 and (d3) HFSEN4 recorded after keeping in PBS (pH=7.4) for 45 days (Scale bar = 10 μm). 248

Figure 6.14 Scanning electron micrographs of CSN1 (a1), AFCSN1 (a2), HFCSN1 (a3), CSN2 (b1), AFCSN2 (b2) and 250

HFCSN2 (b3), recorded after keeping in PBS (p^H=7.4) for 45 days (Scale bar = 10 μm).

Figure 6.15 FT-IR spectra of pure PCL (black) and pure MEH-PPV (red). 250

Figure 6.16 FT-IR spectra of blended MEH-PPV:PCL electrospun nanofibers before and after surface functionalization using (a) APTES and (b) 1,6-Hexanediamine. 251

Figure 6.17 FT-IR spectra of core-sheath MEH-PPV:PCL nanofibers before and after surface functionalization using (a) APTES and (b) 1,6-Hexanediamine. 252

Figure 6.18 (a) Elemental composition in different blended MEH-PPV:PCL electrospun nanofibers before and after functionalization. Peak deconvolutions of high-resolution C1s XPS spectra of (b) SEN1 (c) AFSEN1 and (d) HFSEN1. 253

Figure 6.19 (a) Elemental composition in different cores-sheath MEH-PPV:PCL electrospun nanofibers before and after functionalization. Peak deconvolution of high-resolution C1s XPS spectra of (b) CSN1 (c) AFCSN1 and (d) HFCSN1. 256

Figure 6.20 Probable interaction mechanisms of PCL with APTES (Scheme I) and MEH-PPV with 1,6-Hexanediamine (Scheme II) based on XPS and FTIR results. 259

Figure 6.21 Probable interaction mechanisms of MEH-PPV with APTES (Scheme I) and MEH-PPV with 1,6-Hexanediamine (Scheme II) based on XPS and FTIR results. 260

Figure 6.22 Percentage of hemolysis (Mean ± S.D, n=3) shown by the non-functionalized and functionalized (a) blended MEH-PPV:PCL electrospun meshes and (b) core-sheath electrospun meshes as compared to negative control (Phosphate buffer saline, pH= 7.4) and positive control (Triton X 100). 262

Figure 6.23 Percentage cell viability on different blended MEH-PPV:PCL electrospun meshes in direct contact after 24 h of culture as compared to tissue culture plastic (TCP) as a negative control and tert butyl maleate as a positive control. (a) viability of 3T3 fibroblasts and (b) viability of PC12 cells expressed as percentage of negative control. Data were Mean ± S.D, n=4.* and # indicate significance difference at p≤0.01 and p≤0.05 between the functionalized and non-functionalized blended electrospun meshes. 263

Figure 6.24 Percentage cell viability on different electrospun core-sheath MEH-PPV:PCL meshes in direct contact after 24 h of culture as compared to tissue culture plastic (TCP) as a negative control and tert butyl maleate as a positive control. (a) viability of 3T3 fibroblasts and (b) viability of PC12 cells expressed as percentage of negative control. Data were Mean ± S.D, n=4. # indicates significance difference at p≤0.01 and p≤0.05 between the functionalized electrospun meshes and their non-functionalized counterparts. 263

Figure 6.25 Representative confocal images with phase contrast overlay of 3T3 fibroblasts stained with calcein AM (green), EthD-1 (red) and DAPI (blue) during live/dead assay after 24 of culture on control tissue culture plastic (TCP) (a1), electrospun PCL mesh (b1), SEN1 (c1), SEN2 (d1), SEN3 (e1), SEN4 (f1), AFSEN1 (g1), AFSEN2 (h1), AFSEN3 (i1), AFSEN4 (j1), HFSEN1 (k1), HFSEN2 (l1), HFSEN3 (m1) and HFSEN4 (n1). Similarly, representative live/dead stained confocal images of 3T3 fibroblasts after 48 of culture on control tissue culture plastic (TCP) (a2), electrospun PCL mesh (b2), SEN1 (c2), SEN2 (d2), SEN3 (e2), SEN4 (f2), AFSEN1 (g2), AFSEN2 (h2), AFSEN3 (i2), AFSEN4 266

(j2), HFSEN1 (k2), HFSEN2 (l2), HFSEN3 (m2) and HFSEN4 (n2) [Scale bar=75 μm].

Figure 6.26 Representative confocal images with phase contrast overlay of 3T3 fibroblasts stained with calcein AM (green), EthD-1 (red) and DAPI (blue) during live/dead assay after 24 of culture on control tissue culture plastic (TCP) (a1), electrospun PCL mesh (b1), CSN1 (c1), CSN2 (d1), AFCSN1 (e1), AFCSN2 (f1), HFCSN1 (g1) and HFCSN2 (h1). Similarly, representative live/dead stained confocal images of 3T3 fibroblasts after 48 of culture on control tissue culture plastic (TCP) (a2), electrospun PCL mesh (b2), CSN1 (c2), CSN2 (d2), AFCSN1 (e2), AFCSN2 (f2), HFCSN1 (g2) and HFCSN2 (h2) [Scale bar=75 μm]. 267

Figure 6.27 Quantitative analysis of (a) cell density per field of view, (b) cell area (average area covered by single cell) and (c) percentage of cell spreading on the non-functionalized and functionalized blended MEH-PPV:PCL electrospun meshes. Data were presented as Mean ± S.D, n=6.* and # indicate statistically significant difference at $p \leq 0.01$ and $p \leq 0.05$, respectively. 268

Figure 6.28 Quantitative analysis of (a) cell density per field of view, (b) cell area (average area covered by single cell) and (c) percentage of cell spreading on the non-functionalized and functionalized electrospun core-sheath MEH-PPV:PCL meshes. Data were presented as Mean ± S.D, n=6. * and # indicate statistically significant difference at $p \leq 0.01$ and $p \leq 0.05$, respectively. 269

Figure 6.29 Scanning electron micrographs of 3T3 fibroblasts after 3 days culture on SEN1 (a1), SEN2 (b1), SEN3 (c1), SEN4 (d1), AFSEN1 (a2), AFSEN2 (b2), AFSEN3 (c2), AFSEN4 (d2), HFSEN1 (a3), HFSEN2 (b3), 272

HFSEN3 (c3) and HFSEN4 (d3) [Scale bar=20 μm]. Insets of (a1-d3) show magnified image of green circled region [Scale bar=10 μm]. Red and yellow arrows indicate the direction of cell alignment and filopodia/lamellipodia like extensions, respectively.

Figure 6.30 Scanning electron micrographs of 3T3 fibroblasts after 3 days culture on CSN1 (a1), CSN2 (b1), AFCSN1 (a2), AFCSN2 (b2), HFCSN1 (a3) and HFCSN2 (b3) [Scale bar=20 μm]. Insets of (a1-b3) show magnified image of green circled region [Scale bar=10 μm]. Red and yellow arrows indicate the direction of cell alignment and filopodia/lamellipodia like extensions, respectively. 273

Figure 6.31 Immunolabelling of beta (III) tubulin in differentiated PC12 cells with DAPI stained nuclei after 7 days of culture on the non-functionalized blended MEH-PPV:PCL electrospun meshes (SEN1, SEN2, SEN3 and SEN4), APTES functionalized blended MEH-PPV:PCL electrospun meshes (AFSEN1, AFSEN2, AFSEN3 and AFSEN4), 1,6-Hexanediamine functionalized blended MEH-PPV:PCL electrospun meshes (HFSEN1, HFSEN2, HFSEN3 and HFSEN4), and collagen coated blended MEH-PPV:PCL electrospun meshes (CSEN1, CSEN2, CSEN3 and CSEN4). White arrows show neuronal cell bodies with at least one neurite formed. Red arrows represent neurons with long branched neurites and/or growth cones. Inset of SEN1 shows confocal images of stained PC12 cells cultured on collagen-coated cover slip for 7 days. 275

Figure 6.32 Immunolabelling of beta (III) tubulin in differentiated PC12 cells with DAPI stained nuclei after 7 days of culture on non-functionalized core-sheath electrospun meshes (CSN1 & CSN2), APTES functionalized core-sheath electrospun meshes (AFCSN1 & AFCSN2), 1,6- 276

Hexanediamine functionalized core-sheath electrospun meshes (HFCSN1 & HFCSN2) and collagen coated core-sheath electrospun meshes (CCSN1 & CCSN2). White arrows show neuronal cell bodies with at least one neurite formed. Red arrows represent neurons with long branched neurites and/or growth cones.

Figure 6.33 Quantitative analysis of formation and outgrowth in terms of (a) percentage of neurite-bearing cells and (b) neurite length per cell on the non-functionalized, APTES functionalized, 1,6-Hexanediamine functionalized and collagen coated blended MEH-PPV:PCL electrospun meshes along with collagen-coated glass.* and # indicate statistically significant difference from the non-functionalized electrospun meshes at $p \leq 0.01$and $p \leq 0.05$, respectively. 277

Figure 6.34 Quantitative analysis of neurite formation and outgrowth in terms of (a) percentage of neurite-bearing cells and (b) neurite length per cell on the non-functionalized, APTES functionalized, 1,6-Hexanediamine functionalized and collagen coated core-sheath MEH-PPV:PCL electrospun meshes along with collagen-coated glass.* and # indicate statistically significant difference from the non-functionalized electrospun meshes at $p \leq 0.01$and $p \leq 0.05$, respectively. 277

Figure 6.35 Scanning electron micrographs of PC12 cells after 7 days cultured on SEN1 (a1), SEN2 (b1), SEN3 (c1), SEN4 (d1), AFSEN1 (a2), AFSEN2 (b2), AFSEN3 (c2), AFSEN4 (d2), HFSEN1 (a3), HFSEN2 (b3), HFSEN3 (c3), HFSEN4 (d3), CSEN1 (a4), CSEN2 (b4), CSEN3 (c4) and CSEN4 (d4). Red arrows show neurite projections on different electrospun meshes. Scale bar = 5 μm. 281

Figure 6.36 Scanning electron micrographs of PC12 cells after 7 282

days cultured on pristine CSN1 (a1), CSN2 (b1), AFCSN1 (a2), AFCSN2 (b2), HFCSN1 (a3), HFCSN2 (b3), CCSN1 (a4) and CCSN2 (b4). Red arrows show neurite projections on different electrospun meshes. Scale bar = 5 μm.

Figure 6.37 (a) Schematic illustration of the electrical stimulation experiment using a custom made electrical stimulation set up ; (b) photograph of self made cell culture plate with different electrospun MEH-PPV:PCL meshes (orange colur) fixed on it for electrical stimulation experiment; (c) photograph of the electrical stimulation experiment in situ. 283

Figure 6.38 Confocal images with phase contrast overlay of beta (III) tubulin immunostained PC12 cells cultured for 7 days on the various blended electrospun meshes under no electrical stimulation (a1-AFSEN1, b1-AFSEN2, c1-AFSEN3, d1-AFSEN4, e1-HFSEN1, f1-HFSEN2, g1-HFSEN3, h1-HFSEN4, i1-CSEN1, j1-CSEN2, k1-CSEN3 and l1-CSEN4) and under electrical stimulation of 500 mV/cm for 2h/day (a2-AFSEN1, b2-AFSEN2, c2-AFSEN3, d2-AFSEN4, e2-HFSEN1, f2-HFSEN2, g2-HFSEN3, h2-HFSEN4, i2-CSEN1, j2-CSEN2, k2-CSEN3 and l2-CSEN4) [Scale bar = 75 μm]. 284

Figure 6.39 Confocal images with phase contrast overlay of beta (III) tubulin immunostained PC12 cells cultured for 7 days on the various core-sheath electrospun meshes under no electrical stimulation (a1-AFCSN1, b1-ACSN2, c1-HFCSN1, d1-HFCSN2, e1-CCSN1, f1-CCSN2) and under electrical stimulation of 500 mV/cm for 2h/day (a2-AFCSN1, b2-AFCSN2, c2-HFCSN1, d2-HFCSN2, e2-CCSN1, f2-CCSN2) [Scale bar = 75 μm]. 285

Figure 6.40 (a) Percentage of neurite bearing cells, (b) Neurite per cell, (c) Neurite length per cell and (d) Median neurite 286

length of differentiated PC12 cells on the various blended MEH-PPV:PCL electrospun meshes without electrical stimulation and with electrical stimulation. Data were Mean ± S.D. * and # indicate statistical significance difference from unstimulated PC12 cells at $p \leq 0.01$ and $p \leq 0.05$, respectively.

Figure 6.41 (a) Percentage of neurite bearing cells, (b) Neurite per cell, (c) Neurite length per cell and (d) Median neurite length of differentiated PC12 cells on the various core-sheath MEH-PPV:PCL electrospun meshes above without electrical stimulation and with electrical stimulation. Data were Mean ± S.D. * and # indicate statistical significance difference from unstimulated PC12 cells at $p \leq 0.01$ and $p \leq 0.05$, respectively. 287

Figure 6.42 Current signal recorded (upto 400 s) during electrical stimulation of PC12 cells through various blended MEH-PPV:PCL electrospun meshes and core-sheath MEH-PPV:PCL electrospun meshes under a constant potential of 500 mV/cm for 2 h, applied in chronoamperometric technique in pulsed mode (pulse duration 1 ms). 291

List of abbreviations

Abbreviation	Meanings
0D	Zero dimensional
1D	One dimensional
2D	Two dimensional
3D	Three dimensional
3T3	3-day transfer, inoculum 3×10^5 cells
AAO	Anodic aluminum oxide
AB	Acid base
Ag	Argentum (Silver)
AO	Acridine orange
Ar	Argon
Au	Aurum (Gold)
APS	Ammonium peroxydisulfate
APTES	(3-Aminopropyl)triethoxysilane
AFCSN1	(3-Aminopropyl)triethoxysilane functionalized core-sheath nanofibers: 0.6 mL/h
AFCSN2	(3-Aminopropyl)triethoxysilane functionalized core-sheath nanofibers: 1 mL/h
AFSEN1	(3-Aminopropyl)triethoxysilane functionalized solid electrospun nanofibers:20:80 (v/v)
AFSEN2	(3-Aminopropyl)triethoxysilane functionalized solid electrospun nanofibers:40:60 (v/v)
AFSEN3	(3-Aminopropyl)triethoxysilane functionalized solid electrospun nanofibers:50:50 (v/v)
AFSEN4	(3-Aminopropyl)triethoxysilane functionalized solid electrospun nanofibers:60:40 (v/v)
BDNF	Brain-derived neurotrophic factor
BOC	*tert*-butyloxycarbonyl
BSEs	Back scattered electrons
CHO	Aldehyde

CCD	Charge coupled detector
Ch	Chitosan
cm	Centimetre
CO_2	Carbon dioxide
CNT	Carbon nanotubes
CSA	Camphor sulfonic acid
COOH	Carboxyl
CP	Conducting polymer
CSN1	Core-sheath nanofibers: 0.6 mL/h
CSN2	Core-sheath nanofibers: 1 mL/h
DAPI	4',6-Diamidino-2-Phenylindole
DB-PPV	2,3-dibutoxy-1,4-poly(phenylenevinylene)
DC (dc)	Direct current
DO-PPV	2,5-dioctyloxy-l,4-poly(phenylenevinylene)
DPPH	1,1-diphenyl-2-picrylhydrazyl
DNA	Deoxyribonucleic acid
DRG	Dorsal root ganglion
EB	Emeraldine base
ES	Emeraldine salt
EtBr	Ethidium bromide
ECM	Extracellular matrix
eV	Electron volt
$FeCl_3$	Ferric chloride
FWHM	Full width at half maxima
FT-IR	Fourier transform infrared spectroscopy
HOMO	Highest occupied molecular orbital
HFCSN1	1,6-Hexanediamine functionalized core-sheath nanofibers: 0.6 mL/h
HFCSN2	1,6-Hexanediamine functionalized core-sheath nanofibers: 1 mL/h
HFSEN1	1,6-Hexanediamine functionalized solid electrospun nanofibers:20:80 (v/v)
HFSEN2	1,6-Hexanediamine functionalized solid electrospun

	nanofibers:40:60 (v/v)
HFSEN3	1,6-Hexanediamine functionalized solid electrospun nanofibers:50:50 (v/v)
HFSEN4	1,6-Hexanediamine functionalized solid electrospun nanofibers:60:40 (v/v)
H_2O	Dihydrogen monoxide (Water)
HCl	Hydrochloric acid
Hz	Hertz
ICPs	Intrinsically conducting polymers
IUPAC	International Union of Pure and Applied Chemistry
LUMO	Lowest unoccupied molecular orbital
LEB	Leucoemeraldine
MDMO-PPV	Poly[2-methoxy-5-(3′,7′-dimethyloctyloxy)-1,4-phenylenevinylene]
MDA-MB-231	M.D. Anderson Metastatic Breast adenocarcinoma
MEH-PPV	Poly[2-methoxy-5-(2-ethylhexyloxy)-1,4-phenylenevinylene]
MnO_2	Manganese dioxide
MO-$FeCl_3$	Methyl orange-ferric chloride
MTS	3-(4,5-dimethylthiazol-2-yl)-5-(3- carboxymethoxyphenyl)-2-(4-sulfophenyl)-2H-tetrazolium, inner salt)
NH_2	Amine
N_2	Nitrogen
NA	Nigraniline
NH_3	Ammonia
NHS	N-hydroxysuccinimide
NIH 3T3	National Institutes of Health
NGF	Nerve growth factor
NMR	Nuclear Magnetic Resonance
NMP	N-methyl pyrrolidone
NT-3	Neurotrophins-3
OH	Hydroxyl
O_2	Oxygen
O-I	Organic in inorganic

O-O	Organic in organic
PA	Polyacetylene
PADPA	*p*-aminodiphenylamine
PAni	Polyaniline
PCL	Polycaprolactone
PC12	Pheochromocytoma
PDLLA	Poly-D,L-lactide
PE	Poly(ethylene)
PEB	Protoemeradine
PEDOT	Poly (3,4-ethylenedioxythiophene)
PEG	Poly(ethylene glycol)
PEO	Polyethylene oxide
PHEMA	Polyhydroxyethylmethacrylate
PLA	Poly(lactic acid)
PLGA	Poly(lactic-co-glycolic acid)
PLLA	Poly(L-lactide)
PMAA	Poly(methacrylic acid)
PMAS	Poly(2-methoxyaniline-5-sulfonate)
PMMA	Poly (methyl methacrylate)
PNB	Pernigraniline
PP	Polypropylene
PPP	Poly(p-phenylene)
PS	Polystyrene
PPy	Polypyrrole
PPV	Poly(p-phenylene vinylene)
Pt	Platinum
PT	Polythiophene
PTM	Particle track-etched membranes
PU	Poly(urethane)
PVA	Polyvinyl alcohol
P3MT	Poly(3-methylthiophene)
PVC	Polyvinyl chloride
PET	Polyethylene terephthalate

PTFE	Polytetrafluoroethylene
PVDF	Polyvinylidene fluoride
RBC	Red blood corpuscles
RGC	Retinal ganglion cell
RGD	Arginylglycylaspartic acid (Arg-Gly-Asp)
RNA	Ribonucleic acid
SAM	Self-assembled monolayer
SPR	Surface plasmon resonance
SEM	Scanning electron microscopy
SEN1	Solid electrospun nanofibers:20:80 (v/v)
SEN2	Solid electrospun nanofibers:40:60 (v/v)
SEN3	Solid electrospun nanofibers:50:50 (v/v)
SEN4	Solid electrospun nanofibers:60:40 (v/v)
SEs	Secondary electrons
Si	Silicon
SO_2	Sulfur dioxide
TEM	Transmission electron microscopy
UV-Vis	Ultra violet visible spectroscopy
V_2O_5	Vanadium pentoxide
XPS	X-ray photoelectron spectroscopy
XRD	X-ray diffraction