CHAPTER I
INTRODUCTION

Tissue engineering is the application of knowledge and expertise from a biomedical field, to develop and manufacture therapeutic products that utilize the combination of matrix scaffolds with viable human cell systems or cell responsive biomolecules derived from such cells, for the repair, restoration, or regeneration of cells or tissue damaged by injury, disease, or congenital defects. The ability of cell to grow into tissue and maintain tissue–specific function depends critically on many factors, such as the cell-tissue and cell-cell interaction and the organotypic extracellular matrix (ECM) [1]. ECM molecules surround the cells to provide mechanical support and regulate cellular activities. The ultimate goal of the scaffold design is to produce an ideal structure that can replace the natural ECM until host cells can repopulate and resynthesize a new natural matrix. Natural and synthetic nanofibers are widely used for tissue repair, and these fibrous scaffolds are mechanically stable and capable of functioning biologically in the implant site. In addition, biodegradable materials are required for repair or remodeling, not necessarily long-term stability. Manufacturing feasibility, the ability to form final product design, short-term mechanical properties with non toxicity from degradation products are prerequisite essentials for these materials.

From this view point, electrospinning process has recently been drawn strong attention in biomedical engineering, providing a basis for the fabrication of unique matrix and scaffold for tissue engineering. Electrospinning is a spinning method that can produce polymer fibers with diameters ranging from several micro to 100 nm or less under a high-voltage electrostatic field operated between a metallic nozzle of a syringe and a metallic collector in air [2]. The fibers are typically deposited in the form of a nonwoven fabric onto a target metallic collector through a random deposition process of projected jet of polymer solution, the so-called cone jet or instable jet [3]. The accumulated charges on the polymer solution ejected from the nozzle induce the radial charge repulsion in the electric field, which induces the instable jet. Many parameters can influence the transformation of polymer solutions into nanofibers through electrospinning. These parameters include system parameters such as polymer molecular weight, molecular weight distribution and the solution properties (e.g. viscosity, elasticity, conductivity, and surface tension), process parameters, such as flow rate, electric potential, distance between the tips and the collecting screen, motion of collector and ambient parameters such as solution temperature, humidity, and air velocity in the electrospinning chamber. There for, these parameters should be carefully optimized while controlling fiber diameter and its alignment.

There is an increasing interest in developing new coating to improve biocompatibility and to prepare biomaterial surface that can either be resistant or enhance cellular adhesion. Being the focus of many researches, the most important step toward this end concerns the improvement at the nano-scale and micro-scale of materials which surface properties can be turned to control cellular responses such as adhesion, motility, spreading, growth and another. Many kinds of coating material have been used for the fabrication of films coating such as leaching of glass, sol-gel deposition, chemical vapor deposition (CDV), sputtering, grafting and layer-by-layer (LBL) self assembly [4]. Compare to other strategies, electrostatic self-assembly approach offers several advantages. It is easy to operate and very flexible. It can be applied to almost any type of surface that supports charges and substrate part of any shape. It is done in aqueous media and requires no organic solvents or special apparatus. The assembly process is quick and can be fully automated. The principle of this technique can be summarizes as follow. A substrate successively dipped in dilute solution of oppositely charged polyelectrolyte leading to a layer-by-layer deposition mode. Each adsorption step leads to reversal of charges allowing the deposition of the next layer until it becomes polyelectrolyte multilayer thin films (PEMs) [5]. Key parameters that influence the growth of multilayer thin films are type of polyelectrolyte, concentration of polyelectrolyte, concentration of salt, deposition time and pH condition. Suitable support materials must carry a minimal surface charge such as glass slide, quartz, silicon wafer, mica and gold.

The ultimate aim of this research, which was designed to encompassed 3 main stages, is to improve cell adhesion on electrospun fibrous scaffolds. The first stage of the research focuses on seeking the most appropriate PEM system for cell adhesion. PEMs were thus prepared from Poly (diallydimethyl ammonium chloride) (PDADMAC), Poly (sodium 4-styrene sulfonate) (PSS), gelatin and Chitosan on various substrates. Properties of the prepared PEMs, that are film thickness, hydrophilic/hydrophobic property and film stability in cultured medium solution of the prepared PEMs were determined. In the second stage, the L929 cell behaviors, that are viability, proliferation and spreading on PEMs coated glass cover slips were explored, taking into account the effects of the type of polyelectrolyte at the outermost layer and the number of layers. The final stage started from electrospinning of Poly (ε-caprolactone) (PCL) nanofibrous scaffolds. The nanofibrous scaffolds were subsequently coated with PEMs prior to cell seeding and culturing. The *in vitro* response of the L929 cell on the coated scaffolds was then determined.