CHAPTER I

INTRODUCTION

Statement of Problem

Chitosan, prepared by alkaline deacetylation of chitin, is a biodegradable, biocompatible and inexpensive natural polymer comprising of β-(1,4)-2-amino-2-deoxy-D-glucopyranose units [1, 2, 3]. It has gained marked attraction in recent years owing to its potential applications in medicine, cosmetics, agriculture and biomaterials. In particular, excellent activity as a wound healing accelerator [4, 5, 6] combined with antibacterial capability and good tissue compatibility of chitosan made it become an excellent wound dressing material [7, 8, 9, 10, 11]. However, limited solubility of chitosan in water and common organic solvents inhibited its extensive studies and utilization [12].

Carboxymethylation reaction of chitosan with monochloroacetic acid in alkali solutions results in a water-soluble chitin derivative, so-called carboxymethylchitosan (CMC). Precedents demonstrated potential uses of CMC especially in a wound healing application due to its antibacterial activity, non-cytotoxicity, biocompatibility and excellent water swellability [13, 14]. In addition, it was also non-thrombogenicity and thus was suitable for use as blood-contacting materials [15]. However, the wound healing mechanism of CMC has not been fully understood [16]. Chemical modification of CMC [17], or physical blending of another polymer into CMC [13] has been widely studied to obtain resulting materials with novel properties. Due to its solubility in water, formation of network structure of CMC is necessary when it is intentionally used as a wound dressing material. Only limited numbers of studies reported the investigation of CMC network formation [18, 19, 20]. Glutaldehyde was mostly used as a crosslinking agent to form CMC-based interpenetrating networks (IPNs). Additionally, formation of network structure can also promote miscibility of CMC with another type of polymer [20].

In the current work, polydimethylsiloxane (PDMS) or poly(ethylene glycol) (PEG) was interpenetrated into chitosan or CMC polymer networks. Polydimethylsiloxane (PDMS) is of particular interest in this work owing to their

unique properties, e.g. low toxicity, high oxygen permeability, good flexibility, good thermal and oxidative stability [21]. Highly flexible properties of PDMS arise from its low glass transition temperature (T_g ~ –125°C). It is also widely used in medical applications owing to its biocompatibility, high oxygen permeability and good oxidative stability [22]. PEG is a well-known nontoxic polymer, which is favorable for most of medical applications [23, 24]. Its water solubility is highly dependent on its molecular weight. Incorporation of PDMS/PEG into chitosan/CMC is thus of particular interest. However, a major limitation of incorporation of PDMS/PEG into chitosan/CMC is their immiscibility, resulting in phase separation. Chemical crosslinking of PDMS/PEG in chitosan/CMC should improve the miscibility of the system. PDMS/PEG-modified chitosan/CMC semi-interpenetrating polymer networks (semi-IPNs) were herein prepared using water soluble hexamethylene-1,6-di-(aminocarboxysulfonate) (HDA) crosslinker. Effect of the molecular weights and concentrations of PDMS/PEG in the networks on the properties such as percent crosslinking, water swelling behavior, surface morphology, tensile strength, water contact angles, and water vapor permeability, were investigated.

Research objectives

1. To prepare semi-interpenetrating polymer networks (semi-IPNs) of chitosan or carboxymethylchitosan (CMC) hydrogels containing PDMS or PEG

2. To investigate the effect of the molecular weights and concentrations of PDMS and PEG on the properties of modified chitosan/CMC semi-IPNs such as water swelling behavior, percent crosslinking, surface morphology, tensile strength, water contact angles, and water vapor permeability

Research scopes

1. To synthesize PDMS having 2K and 8K and verify their chemical structures, functional groups, molecular weights and thermal properties

2. To interpenetrate PDMS/PEG into chitosan/CMC networks and characterize their properties, e.g. water swelling behavior, percent crosslinking, surface morphology, tensile strength, water contact angles, and water vapor permeability