

## CHAPTER I

### INTRODUCTION

Many industries have been using eggs as a component of products, such as foods, cosmetics, pharmaceuticals etc. Thus, a large amount of eggshells is generated, causing pollution because it is a nutrition source for microorganism in the environment. Eggshell is a bio-waste, and there are many disposal methods for this waste, such as fertilizer, animal-feed ingredient, and discarded in municipal dumps. (Daengprok, *et al.*, 2002; Macneil, 1997)

Egg consists of yolk, albumen, and eggshell with the composition of approximately 31, 58, and 11%, respectively, of the total weight of the egg. (Board, *et al.*, 1994) Eggshells are a function of protected impact force, microorganism, and acting gaseous permeability. Chemical composition of the eggshell consists of calcium carbonate (94%), calcium phosphate (1%), magnesium carbonate (1%), and organic substances (4%). (Murakami, *et al.*, 2007) The main component of the eggshell is calcium carbonate ( $\text{CaCO}_3$ ) that is also used in various applications, such as plastics, paints and surface coatings, paper, food, pharmaceuticals, rubber industry, and cosmetic industry.

Medical application in bone has also been attractive since chemical composition of the bone is similar to eggshell, having calcium compound as the main component (approximately 64.85% of the total weight of the bone). (Zhaolin, *et al.*, 2009; Eric, *et al.*, 1999) However, the eggshell cannot be directly used in bone application without eliminating organic matter and converting the form of calcium carbonate to highly pure calcium compound. Moreover, the bone matrix is composed of both inorganic and organic matters. (Rhineland, 1972) The organic matter enhances mechanical and biological properties. Many researchers have been attempting to prepare artificial bone, for example, Neumann (Neumann, *et al.*, 2006) reported common reasons to prepare composite as bone substitution; those are; mechanical properties (elasticity, strength), biocompatibility, processing/shaping, and compensation of acidity. The physical characteristics of bone are highly porous structure, light weight and high strength. Therefore, artificial bone needs to have all

these physical characteristics, and aerogel via freeze-dry method could provide these properties, as compared to other solid materials which give low densities, large open pores, and high surface area. (Czakkel, *et al.*, 2005; Hüsing, *et al.*, 1988)

In this project, synthesis of calcium oxide from eggshell to increase value-added eggshell waste and synthesis of hydroxyapatite from calcium oxide and orthophosphoric acid via sol gel process are carried out. In addition, a novel artificial bone is studied using the synthesized calcium compounds (hydroxyapatite and calcium oxide) and polyvinyl alcohol by aerogel fabrication technique using freeze-drying method to give calcium compound-based aerogel, having bone-like structure.