CHAPTER I
INTRODUCTION

1.1 Background

External fixation is a surgical treatment for fracture fixation in which pins or screws are inserted percutaneously into the bone and attached via external fixators [1]. External fixators may be used as temporary treatment, providing provisional alignment and stability, or as definitive treatment in some fracture cases. Nowadays, metallic biomaterials, including stainless steel, titanium, and cobalt-chromium-based alloys, are manufactured into pins or screws. Since these materials are unable to degrade naturally, pins or screws are usually removed after the bone fracture has healed and fused. It is removed via a second surgery, which inevitably creates holes in the bone that would initiate refracture [2, 3].

Meanwhile, the application of metallic biomaterials has been limited due to the release of toxic metal ions and particles during corrosion and abrasion processes. The phenomenon inflicts inflammation, which reduces the biocompatibility of metallic biomaterials and damages the tissue. Alternatively, three classes of metal have been progressively researched as biodegradable metals: iron- (Fe), zinc- (Zn), and magnesium- (Mg)-based alloys [4, 5]. Nevertheless, biodegradable material implants have weaker structural strength than biomaterial implants. Therefore, partial biodegradable bone pins or screws can be proposed as a potential solution to overcome the problem [6]. The idea is that half of the biodegradable metal pins or screws will remain in the bone and degrade gradually over time. The other part, which meets soft tissue, can be removed after the necessary healing period in order to avoid an allergic reaction. These dissimilar metals' joining will be done using the friction welding method.

Studies on biodegradable metals such as magnesium (Mg) alloy and pure iron (Fe) have been conducted previously. It can be well joined with its respective mother material [2, 5]. By contrast, there is an issue with the degradation control of these two biodegradable metals. The degradable rate of pure iron (Fe) is still relatively slow, specifically 0.2 mm/year. Meanwhile, the degradable rate of magnesium (Mg) implant materials is still relatively fast, specifically 8 mm/year.

Pure zinc (Zn) has a degradable rate of 0.55 mm/year, which is the desired degradable rate [7]. It is the foundation of the conducted study to achieve a new alternative of partially biodegradable bone pins or screws. The biodegradable component (pure zinc) will degrade in bone, while the mother component (stainless steel 316L) will be released from the body later. The selection of stainless steel 316L as a mother component is since this type of metallic biomaterial is easily found on the market.

1.2 Problem Formulation

There are no studies available in literatures and journals regarding the joining of pure zinc (Zn) and stainless steel 316L in medical implant nor engineering to the best of our knowledge. This gap can be explored to achieve a new alternative in the form of partial biodegradable bone pins or screws. The purpose of this work is to answer some uncertainties of (1) can we create a joint between pure zinc (Zn) and stainless steel 316L, (2) how to create an optimal joint strength of it, and (3) how good is the strength of the joint.

1.3 Objectives

In this undergraduate thesis, basic studies will be done with the following objectives:

1. Obtaining friction welding parameters for joining pure zinc (Zn) and stainless steel 316L.
2. Finding out the mechanical properties of the joint between pure zinc (Zn) and stainless steel 316L.

1.4 Benefits

The output of this study is expected to contribute to the development of implant materials in the orthopedic field, as well as contribute to the development of implant materials that are expected to avoid the problems associated with second surgery.

1.5 Scopes

This study is conducted with several limitations:

1. Test materials used are pure zinc (Zn) and stainless steel 316L, which are sold commercially.
2. The mechanical properties analyzed are tensile and bending strengths.

3. The mechanical properties were only examined in terms of friction time at room temperature and pre-heating temperature at an optimal friction time.

1.6 Outline

Generally, the writing of this study consists of five parts, precisely: Chapter I Introduction, describing the study background, problem formulation, objectives, benefits, scopes, and outline of the study. Chapter II Literature, explaining the basic theories related to the study. Chapter III Methodology, explaining the method and process to achieve the result and study objectives. Chapter IV Result and Discussion, explaining the outcome obtained and the analysis of the study. Chapter V Conclusion and Recommendation, explaining the conclusions obtained from the outcome as well as recommendations that can be used in further study.