

# CHAPTER 1

## INTRODUCTION

In Southeast Asia the only company that produces zinc Ingot (99.995% Zn) is Padaeng Industry Public Co. Ltd. that is located at Tak province, Thailand [1]. Zinc refinery process has been used for extracting zinc. Each year this process produces large amounts of waste, which causes many problems in Thailand as well as with other zinc industries around the world [2, 3, 4, 5]. Nowadays the great volume of waste is stored in different types of closed containers or sealed reservoirs or landfill near the mining region. Since landfilling of waste requires a large space, soil occupation and specific closed containers, the expensive cost of making more space and containers becomes an economic problem. This waste contains many types of heavy metal oxides, such as PbO, CoO, CdO, etc. with high percentage of sulphur, which are toxic and hazardous. Therefore environmental problem is also a concern.

In order to solve these problems, Padaeng Industry Public Co., Ltd, National Metal and Materials Technology Center (MTEC) and Chulalongkorn University have worked on the possibility of transformation of waste to other valuable forms that are safe for the environment. A possible solution would be the utilization of the vitrification process and glass-ceramics technology, as the chemical analysis of this waste shows many other compounds besides the hazardous components that are suitable for formation of glass and glass-ceramics. The transformation of waste to glass-ceramic materials costs more money than those of cement due to the fact that glass-ceramic process consumes higher energy for thermal treatment. However, compressive strength of cement is very low and the encapsulation of heavy metals from cement structures has not been ensured [3]. Alternatively glass-ceramic materials contain amorphous structures that are capable of trapping heavy metals. The mechanical strength and chemical durability of glass-ceramics are better than cement. Moreover, developing the original chemical composition of raw materials can control the final product of glass-ceramics. Glass-ceramic products are useful in various applications such as construction materials, glass frit, refractories and fibers.

Padeang Industry Public Co., Ltd supplied zinc waste for this research. National Metal and Materials Technology Center (MTEC) supported the research through funding and providing some of the equipment used in the experiment, such as SEM, DTA, EDX, XRD, XRF, AAS, microscope, and furnace. Chulalongkorn University supported the research by providing a glass-melting furnace.

The aim of this study was to utilize the waste as a raw material for developing glass-ceramic and immobilization of hazardous elements in zinc waste by vitrification process. This study was also concerned about the effects of initial glass compositions on properties of glass ceramics after heat treatment. Crystal phase analysis, crystal morphology, physical properties, mechanical strength, and chemical durability were examined. The objectives of this study are described as follows;

1. To introduce the method to convert zinc hydrometallurgical waste into valuable product.
2. To study the properties of zinc hydrometallurgical waste and introduce the method to convert zinc waste to glass-ceramic materials.
3. To study the thermal process that control crystalline precipitation in glass-ceramics.
4. To study the effect of glass composition on properties of glass and glass-ceramics.
5. To study the thermal properties, microstructure, mechanical properties and chemical durability of glass and glass-ceramics.