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Research Article

Preparation of Aluminum Alloy from Recycling Cans Wastes

Shaymaa Abbas Abdulsada[a*]

[a]University of Kufa, Collage of Engineering, Iraq

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Abstract

The aluminum recycling industry is mature and well developed. Since 2001 the production of secondary aluminum in the US from recycling has actually exceeded that of primary aluminum from smelting. Results showed after recycling aluminum cans obtained aluminum alloy contains element of manganese as a major alloy. Micro hardness Vickers after testing homogeneous sample alloy showed the sample have value = 50.59 kg/mm^2.

Keywords: *Aluminum alloy, Recycling, Aluminum cans.*

1. Introduction

Aluminum compounds from 8 per cent of the earth's crust and are present in most rocks, vegetation and animals. The aluminum is indeed the third most common crustal element and most common crustal metal on earth. Pure aluminum is a very reactive element and is never found as the free metal in nature. It is very lightweight and soft. It has to be combined with small quantities of other materials like iron, silicon, zinc, copper, magnesium, tin, titanium, lithium for example to produce array of alloys of different properties for different purposes (Zheng Luo et al,2008;IAI, 2006).

Aluminum makes a key contribution to fuel-efficient engines in transportations. It facilitates the construction of corrosion-resistance and low maintenance buildings. Aluminum is also extensively used in packaging for protection, storage and preparation of food and beverages. Aluminum can be rolled into ultra-thin foils which are light, strong and have a unique barrier and insulation qualities to preserve food and beverages against ultra-violet light, and bacteria (IAI,2006; HE Mingqian Belinda,2006)

Aluminum packages are secured, tamper-proof, hygienic, easy to open and recyclable. Almost every aluminum product that is produced commercially can be recycled after its end of life, without losing its metal properties or quality. As there is an increased used in recycled aluminum in many different kinds of application, the aluminum metal is also known as the green metal (Hong Zheng et al,2004;)

The Aluminum Association, Can Manufacturers Institute (CMI), and Institute of Scrap Recycling Industries (ISRI) released statistics on May 20, 2005 indicating that Americans and the can recycling industries recycled 51.5 billion aluminum cans in 2004, for a beverage can recycling rate of 51.2 percent. This reflected a 1.2 percent increase over the 2003 rate and the first increase since 1997 (Andreas Detzel et al,2009; Arikata, M,1997)

The focus of this study is mainly on the recycling of aluminum beverage cans. The reason of the focus is due to the fact that aluminum beverage cans are by far the most recycled consumer beverage packages globally, by units, pounds and percentage recycled. It amounts to more than twice the recycling rate and recycled content percentages for beverage packages of other materials.

2. Experimental Part

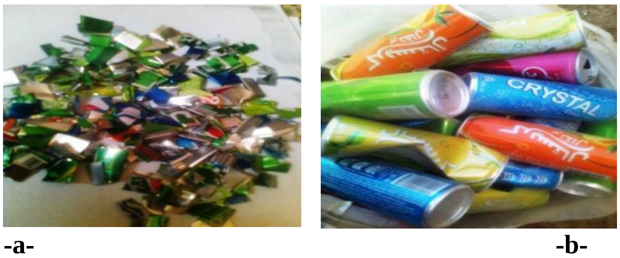
2.1 Samples Preparation

A- Preparation Sample Alloy

The recycling process takes place in two basic steps:

Stage 1 – Can Shredding

In the first step, aluminum cans are shredded into pieces the size of a walnut, as shown in Figure 1.



-a- **-b-**

Figure 1 Aluminum Cans: a) before cutting, b) after cutting.

*Corresponding author: **Shaymaa Abbas Abdulsada**

Stage 2 –Melting and Casting

Following the can shredding process, any lacquer or paint on the aluminum is removed at (around 300°C) through the shreds on a slowly moving insulated conveyor. After being de-coated, the aluminum shreds are then fed into melting furnaces. The molten metal is treated to remove impurities before casting the aluminum. Casting process includes the die designing and manufacturing. The furnace was used for ingot production type (**Via P.da Cannobia, 10, 20122 MILANO, Italy**) as shown in Fig.ure 2.These ingots as shown in Figure 3, were prepared by melting aluminum at 675 °C then remain for 5 minutes after each element addition and then cast in especially design die.

Figure 2 Electric furnace used in preparation of ingots.

Figure 3 Ingots

The ingots were homogenized at 500°C for 2 hours. Electric furnace type (**Sola Basic SB Lindberg**) was used during this work to homogenize and solutionize the aluminum alloys ingots and the samples .

B- Specimens Machining

Samples machining involves the following steps:
1. Cutting rod of aluminum alloy with (**15 mm**) diameter and (**10 mm**) length.
2. Grinding Process

2.2 Specimen Preparation for Microscopic Analysis

The specimens were prepared in consistent with the standard metallographic techniques. The ultimate objective of such a process was to obtain a flat scratch free, mirror like surface.

From a viewpoint of an ideal sample ready for microstructure examination it must satisfy the following measures:
1. Be representative sample.
2. Have minimum deformation after sectioning, grinding and polishing.
3. Free from grinding and polishing scratches, pits and staining from the etch or subsequent corrosive liquid.
4. A sample polished so that inclusions are presented intact.
5. Enough flatness to allow high magnification.

Standard metallographic examinations using optical microscopy type (**Union / ME-3154**) was used to reveal the specimens structures as shown in Figure 4.

Figure 4 The optical microscopy used to reveal the specimens structures.

2.3 Mechanical Testing

Many mechanical testing have been done as following:-

2.3.1 Hardness Test

Hardness is a measure of a materials' resistance to localized plastic deformation (e.g., a small dent or a scratch). Early hardness tests were based on natural minerals with a scale constructed solely on the ability of one material to scratch another that was softer. Appropriate grinding and polishing were done before subject specimens to hardness tests.

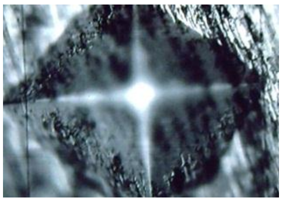


Figure 5 The indenter of of hardness test.

Figure 6 The digital micro Vickers hardness tester

The test was used to conduct the test with a load of 100g for 20 sec.

In this study the way which used to calculate value of micro hardness was Vickers way. The Vickers hardness test uses a square-base diamond pyramid as the indenter which shown in Figure 5.

A Vickers micro hardness testing machine was type [**TH-717, Digital Micro Vickers Hardness Tester**] used to conduct the test with a load of 100 g for 20 sec. as shown in Figure 6.

3. Results and Discussions

3.1. Chemical Analysis of Alloys

Table 1 shown chemical analysis for specimen from alloy which was produced from recycling cans in this study. The analysis has been done in University of Technology /Materials Engineering Department, by using tester **Portable Metals Analyses** type(**ARUN Technology**).

Table 1 Chemical analysis for alloys that used in this study

Weight percent of elements						
Al	**Mn**	**Fe**	**V**	**Cu**	**Cr**	**Zn**
Balance	**0.74**	**0.64**	**0.4**	**0.13**	**0.18**	**0.08**

The Table 1 appears that alloy found in boundary of chemical composition of 3xxx series aluminum alloy that is known from Aluminum Association.

3. 2 Mechanical Properties Tests

3.2.1 Hardness Tests

The measurement of hardness for specimens alloys that cast in die mould after process of casting homogenized as follows shown in Table 2.

Table 2 Appears hardness of the alloys that used in this study.

Condition	**Form**	**Vickers hardness (kg/mm^2)**
As cast	Die casting	55.61
As homogenized	Die casting	50.59

Table 2 shown that alloy have optimum values of hardness, the reason of this values of hardness that alloys containing in chemical composition major alloying elements such as manganese cause to these alloy was non-heat-treatable and may be strengthened by cold work (strain hardening).

3.3. Optical Microscope Testing

The microstructure of sample as cast alloy that used in this study shown in Figure 7 dendrites structures were observed in fast cooling rate samples.

This structure was obtained from the ingot which has been cooled quickly to obtain equi-axed network structure. This network structure is made up of particles of several intermetallic compounds formed by combinations of the alloying elements in this alloy. Some of these compounds are soluble while others have slight or practically insolubility. In cast condition, this alloy contains grain boundary precipitate phases along the grain boundary and near the grain boundary as shown in the following figure.

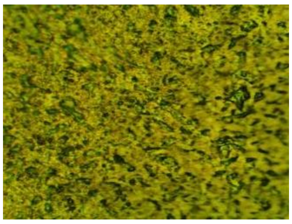


Figure 7 Microstructure of Cast sample alloy, 150 X.

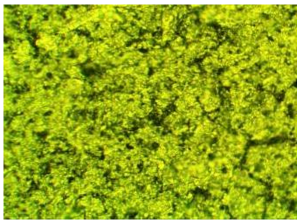


Figure 8 Microstructure of homogenized sample alloy, 50 X

The following figure 8 shows microstructure of alloy sample that homogenized.

From Figure 8 obtained the precipitates were distributed in structure , the grains sizes homogenizing and no found any cracks in alloys

Generally when compare the figures obtained that the microstructure of alloy consist of shape, size and uniform distributing for grains. The effect of homogenized on alloy not appears in optical microscopy because magnification and resolution not enough to photo and analysis the results

4. Conclusions

According to results of present work, the following can be concluded:

1- After recycling aluminum cans obtained aluminum alloy contains element of manganese as a major alloy.

2- Micro hardness Vickers after testing homogeneous sample alloy showed the sample have value = 50.59 kg/mm^2.

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