Student's Card 1 **Recycling metallic packaging**

Module 1- Experimental protocols

Introduction

Napoleon's wars produced millions of dead but something good left: they diffused into Europe the concepts of freedom and equality ... and the use of tin can to store food and beverage. Then, if today we can pick-up an orange-juice or a beer into few grams of metal we have to thank Napoleon.
Metal packaging is a relevant part of the urban wastes and, if selected from the other wastes, they can be easily recycled saving a lot of energy and giving environmental benefits....

Experiment 1

Cut the tin cans made by different materials and mix the pieces together. Use the magnet to separate them. Since steel is mainly made by iron, it is attracted by the magnet meanwhile Aluminium does not. This is how you can use physical properties of Aluminium and steel to tell apart different type of tin cans.

Experiment 2

Wear safety glasses and gloves. Put half of the teaspoon in the clamped test tube using the funnel. Fill about one third of the test tube with the hot water. Heating water beforehand halps to speed up the dissolution of NaOH. The solution should be mixed by using the stirring rod until all the NaOH is dissolved. Then put carefully a piece of steel can into the test tube. In NaOH, first the protective Sn layer that protect steel will react with the strong base forming $Na_2[Sn(OH)_6]$, thus the formation of few bubbles of gas may be observed.

$2\ NaOH + Sn + 4\ H_2O \rightarrow Na_2[Sn(OH)_6] + 2\ H_2\uparrow$

Since steel itself does not react with NaOH, nothing more should be observed.

Then, a piece of Aluminium could be carefully put into the same test tube or in another containing the same solution. Aluminium violently reacts with NaOH forming sodium aluminate:

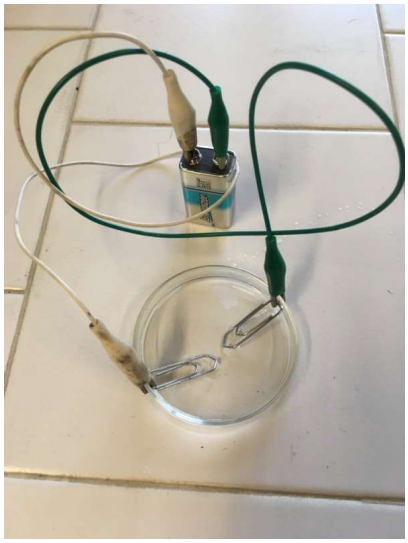
$2\ NaOH + 2\ Al + 6\ H_2O \rightarrow 2\ Na[Al(OH)_4] + 3\ H_2\uparrow$

You have used chemical properties of steel and Aluminium to differentiate tin cans with different compositions.

EIT RawMaterials is supported by the EIT, a body of the European Union

Student's Card 1 Recycling metallic packaging

Experiment 3



About half of a teaspoon of $SnCl_2$ should be dissolved in 50 mL of water. In dilute solution $SnCl_2$ Hydrolysis occurs forming an insoluble compound:

$SnCl_2$ (aq) + H_2O(l) → Sn(OH)Cl (s) + HCl (aq)

A few drops of HCl solution need to be added to move the equilibrium to the left, to avoid that the solution becams cloudy and better the visibility of the following reacton with the metal.The addition of acid also prevent the formation of precipitates by removing the carbonate ions from the water.

Fill 3/4 of the Petri dish with the solution and store it for the experiment 4.

Place some Zn granules in the ramaning solution in the beker, after some time the Zn granules will be coverde by a black a dusty layer of Sn. The following reaction occurs because Zn is more reactive than Sn:

Zn (s) + $SnCl_2$ (aq) → $ZnCl_2$ (aqu) + Sn (s)

A similar reaction is used in the production of tin cans to cover steel with a protective layer of Sn.

Experiment 4.

The solution in the Petri's dish, stored during experiment 3, will be used to perform an electrodeposition experiment. Clamp the paper pins to the Petri's dish edge by using one crocodile clip of each cable (see figure below). Connect the other crocodile clip of each cable to the two poles of the 9V battery. Keep the test apparatus veri still for best results and wait for few minutes. The formation of a metallic web from one paperclip should be observed.

The electric current from the battery induce a non-spontaneous reaction of $SnCl_2$ solution. Sn is reduced to the paperclip connected to the negative pole of the battery (cathode), while Cl_2 gas is formed near that connected to the positive pole of the battery (anode).

$SnCl_2$ (aq) → Cl_2 (g) + Sn (s) ΔV

Electrochemical reduction is used to obtine pure Aluminium from fuesed ores and consume about the 3% of all Word's electric energy. Due to this is much more energy efficient to recycle old Alluminium cans than produce them from the metal contined into ores.

EIT RawMaterials is supported by the EIT, a body of the European Union

Student's Card 1 Recycling metallic packaging

Electrodeposition can be used to cover steel with Sn as well. Thin cans are coverd by Sn simiilarly to the paperclip connected to the negative pole of the battery.

After this workshop it is recomanded to ventilate the room becouse of the different gasses formed during the experiments.

Questions/Quiz 

1. What materials compose the metal package for food?
2. Which are the three main advantage in recycling Aluminum?