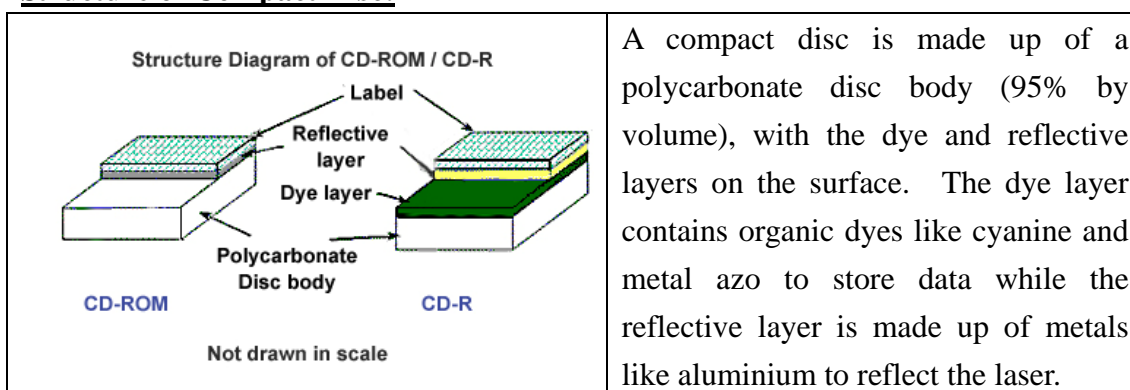


## New Strategies for Compact Disc Recycling

### Introduction:

Every year, huge amounts of compact discs are discarded all over the world. The non-biodegradable polycarbonate, heavy metals and harmful dyes of the discs lead to serious pollution problems. Few countries have started to recycle compact discs and the current process is not efficient, has many drawbacks, involves the use of toxic chemicals and pays no attention to the treatment of dyes. So a modified and more environmentally friendly process is suggested to recycle compact discs.

### Structure of Compact Disc:



### Suggested Compact Disc Recycling Process:

1. The surface of the compact disc is burnished. Hence, the dye layer and the reflective layer at the surface are burnished into powders, which are collected for further treatment. The burnished disc body actually consist of mainly polycarbonate, with very little amount of impurities like dyes and metals left.
2. The burnished compact discs are then washed with ethanol, which acts as a solvent for dissolving the impurities (dyes). After treated with ethanol, the disc body consists only of polycarbonate and can already be recovered.
3. Ethanol is then added to the fine powder of dyes, metals and small amounts of polycarbonate. The dyes dissolve in ethanol, while metals and polycarbonate are left as remains.
4. The dyes dissolved in ethanol is then treated with Fenton's Reagent, which is the combination of ferrous iron (Iron(II) sulphate solution) and hydrogen peroxide, to break down the dyes into mainly carbon dioxide and water.
5. Sodium hydroxide is added to precipitate iron (III) ions or any other metal ions that are present in the solution. The remaining solution is of very few impurities and can be discharged.
6. The metal oxide precipitated as well as the remains in step 3 (metals and polycarbonate) are oxidized by concentrated nitric acid. The metals can be recovered by electrolysis, while the polycarbonate will be left as remains. After



controlling the pH value of solution left after electrolysis, it can be discharged.

### **Advantages over the current processes:**

1. In the current process, the whole compact disc is smashed into powder, which becomes a mixture of dyes, metals and polycarbonate, for further treatment. In our suggested process, the dye and reflective layers are separated from the disc body by burnishing. The polycarbonate disc body, which takes up a total of more than 95% by volume, is already recovered in first stage and can be remoulded to make other useful plastic objects.



2. If the whole disc is smashed into powder, a lot of ethanol is needed to wash it to dissolve the dyes. But as in the suggested method, the dye and metal layers are separated as tiny powder from the polycarbonate disc body by burnishing. The amount of waste needed to be treated with ethanol is greatly reduced. Hence much less ethanol is required.



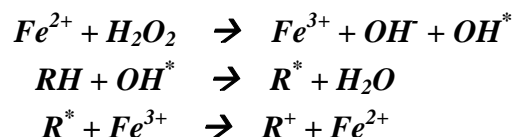
Left: waste to be treated (collected by smashing)

Right: waste to be treated (collected by burnishing)

3. Toxic cyanide is used in the current process to dissolve metals from the powder mixture. In the suggested method, no cyanide is required and all the chemicals used and produced are much more environmentally friendly.
4. Attention is seldom drawn to the treatment of dyes in the current process. Hence, Fenton's method is applied in the suggested method to efficiently break down the dyes to prevent pollution problems.

### **Chemical Principle:**

Fenton's method is a well-known chemical reaction used to treat a great variety of organic wastes or sludge. The Fenton's Reagent is a combination of Iron (II) sulphate and hydrogen peroxide. The mechanisms involved are as follows:

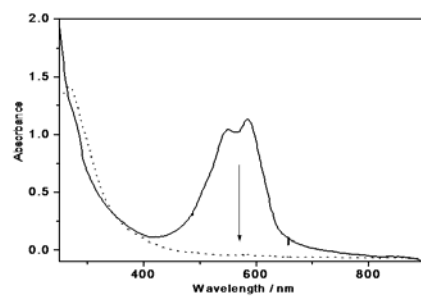


Iron (II) sulphate catalyses the decomposition of hydrogen peroxide to liberate a hydroxyl radical. The hydroxyl radical is one of the most reactive chemical species known, second only to elemental fluorine in its reactivity. With the indiscriminate

nature of by which hydroxyl radical oxidizes organic materials, the hydroxyl radicals can break down the dyes from compact discs. When the reaction completes, the dyes will be broken down into carbon dioxide and water.

### **Results:**

A UV-Vis absorption measurement was then carried out to check whether the dyes had disappeared. From the Absorption spectra of dye-containing waste water before treatment (—) and after (- - - -) treatment with Fenton's reagent, it is concluded that the dyes had been broken down.



### **Further Studies on Fenton's Method:**

#### 1. Types of ions used

Some research has shown that  $\text{Fe}^{3+}$  ions can also catalyze the break down of hydrogen peroxide to liberate hydroxyl radical. An experiment on the reaction rate of Fenton's method using  $\text{Fe}^{2+}$  or  $\text{Fe}^{3+}$  has been conducted by measuring the time required for each type of ion to break down 0.2 g of methyl blue in  $50 \text{ cm}^3$  of water.

Types of ions used	Iron (II)	Iron (III)
Time required	5 minutes and 48 seconds	14 minutes and 43 seconds

These figures agree quite well with the Fenton's Method we applied in the suggested process.

#### 2. Acidic and alkaline medium

0.2 g of methyl blue is dissolved in  $50 \text{ cm}^3$  of water, buffer solution of pH 4 and pH 11. The reaction rate of Fenton's Method (using  $\text{Fe}^{2+}$  as the catalyst) on these three samples is compared.

Medium	Acidic	Neutral	Alkali
Time required	2 minutes and 24 seconds	5 minutes and 48 seconds	The reaction terminates after a short time and the dyes remain

The results show that acidic medium favors Fenton's method while alkaline medium inhibits it. Hence, the pH of the dyes collected from compact disc can be adjusted to below 7 before they are treated with Fenton's method.

### **Conclusion:**

Compared with the current compact disc recycling process, the suggested one is more environmentally friendly and profit-making. It has fulfilled 5 out of 12 principles of Green Chemistry. The suggested method is not a difficult process and the chemical principle (Fenton's method) is well-known. But people are not aware that they can be used to recycle compact disc in this way. It is hoped that this project can draw people's attention to the importance of compact disc recycling.