

## **WP# 27 Yellowing of Polycarbonate Plastics – Sept 9, 2021**

### **Background**

While Chlorine Dioxide is safe to use on a variety of materials, it is classified as an oxidizer and can yellow some plastics such as some polycarbonates and urethane compounds. In order to gain a better understanding of this issue, a method of correcting yellowing in plastics caused by exposure to sunlight was tested on samples of plastic which were yellowed by chlorine dioxide.

The method in question was developed by collectors of old electronics equipment. The plastic casings of these older pieces of equipment were made with ABS plastics that included bromine, which acted as a flame retardant. When exposed to sunlight, the bromine molecules could be destabilized and seep into the plastic, causing the material to take on a yellow color. Several hobbyists with backgrounds in chemistry and plastics engineering worked together to find a solution to the issue. They determined that by applying a hydrogen peroxide-based mixture they called “Retrobrite” to the outside of the plastic and exposing it to UV radiation for several hours, the plastics would return to their original color. The UV once again destabilizes the bromine, however the hydrogen peroxide provides a hydrogen molecule which the free bromine favors bonding to, causing it to be leached out of the plastic. This method was applied to plastics yellowed by chlorine dioxide in this case study in order to attempt to determine the cause of yellowing of some polycarbonates by chlorine dioxide.

### **Case Study**

The case study was performed on three small plastic samples: pieces of medical devices which had been yellowed by chlorine dioxide during a decontamination cycle. These devices were made from polycarbonate and urethane tubing compounds and were of different shapes and sizes. Instead of the original Retrobrite mixture, 40 volume cream developer was used. According to an article by Whitson Gordon on the hobbyist website [www.howtogeek.com](http://www.howtogeek.com), this hair product has been found to have a similar makeup to the original Retrobrite recipe, and is similar in effectiveness while being easier to obtain.

The effectiveness of the method was determined visually by examining images taken before and after the test was performed. This case study only served as an initial verification of the effectiveness of the method as well as the hypothesis that the yellowing is only a surface discoloring and that it is caused by the bromine flame retardant. Further testing would be needed to analyze the method in greater detail.

### **Case Study Testing Procedure**

The samples were cleaned with rubbing alcohol and rinsed with water. After they had dried, the cream developer was applied with a cotton swab to the exterior. The samples were then wrapped in saran wrap to prevent the cream developer from evaporating. The samples were then placed in

direct sunlight in order to expose them to UV radiation. They were exposed for a total of 7 hours, with the cream developer being reapplied twice during the procedure. The samples were also flipped over and rotated every 30 minutes. When finished, they were rinsed with water and examined.

## Results

The following images show the samples before and after the test was performed.



Figure 1: Samples before de-yellowing.



Figure 2: Samples after de-yellowing.



Figures 3a and 3b: Sample A before and after



Figures 4a and 4b: Sample B before and after



Figure 5a and 5b: Sample C before and after

The samples were observed to have considerably less yellowing after the method was applied. However, it was also noted that the method was not equally effective on each of the plastic pieces. There were a few factors that could have caused this. The exact type of plastic was unknown prior to testing, so material differences could be the cause. Two of the pieces have an inner surface, which may not have gotten sufficient exposure to the mixture of UV radiation. Further testing is needed to determine the exact cause of the difference in yellowing.

## Summary

The use of a hydrogen peroxide was able to free the destabilized bromine molecule and remove the yellowing color caused by chlorine dioxide gas exposure. It was noted that the method was not equally effective across all three samples. Further testing would need to be done to determine the exact cause of this discrepancy. The fact that it dramatically reduced the yellowing gave credence to the hypothesis that the yellowing was (1) a surface issue only, and (2) probably related to the bromine content of the plastic.

Gordon, W., 2018. *How to Clean Old, Yellowed Plastic on Retro Computers and Game Systems*. [online] Howtogeek.com. Available at: <<https://www.howtogeek.com/196687/ask-htg-why-do-old-computers-and-game-consoles-turn-yellow/>> [Accessed 1 September 2022].

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