DECORATIVE PLATES FROM EPOXYDIC COMPOSITES

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Leather waste obtained in the leather industry represents a potential source of pollution for the environment, for plants and animals. The ecological treatment of this waste involves quite high costs and only companies with large production capacities can afford them. This paper proposes a method of transforming this waste into ash rich in chromium III and using it as a pigment (green), together with other substances, to obtain new materials. In this sense, it is proposed to use compounds that can incorporate and block the diffusion of the substances back into the environment. To achieve this, a mixture of epoxy polymers, biphenol A and biphenol F, will be used, in a 1:1 ratio, which after the polymerization reaction, with Ancamine 2686, will result in an inert mass. The polymer tiles can then be used as decorative elements for the facades of some buildings.

Keywords: leather waste, epoxy polymer, polymerization

INTRODUCTION

Leather tanning is one of the oldest human activities and remains the most important operation in the flow of leather processing. The resulting fragments of tanned leather from these operations constitute the chromed leather waste, can add up to 25% of the raw hide subjected to process. As hundreds of tons of hides are tanned, large amounts of tanned leather with chromium reach to the order of tons. The specialized scientific literature of the last years presents studies regarding the capture of chromium and retanning using the residual chromium from tanneries. Chromium recovery is based on biological processes (Aliane *et al*., 2001; Pinto *et al*., 2006; Rengaraj *et al*., 2003), complexation-ultrafiltration (Park *et al*., 2008; Turtoi *et al*., 2001; Strathman, 1980), ion exchange processes (Strathman, 1980; Langhammer *et al*., 2008; Wenling *et al*. (2008), adsorption on various materials (Animes *et al*., 2007; Su and Juang, 2002; Junxi *et al*., 2008), electro-coagulation (Morales-Barrera and Cristiani-Urbina, 2008), electrochemical recovery. Studies dedicated to the recovery of residual chromium have been directed towards the production of chromium-based pigments (Sivakumar *et al*., 2000; Lazau *et al*., 2007), ceramic materials, including refractory ceramics (Lazau *et al*., 2007), the incorporation of residual chromium in cement (Sivakumar *et al*., 2000; Lazau *et al*., 2007; Gupta *et al*., 2001). For the residual chromium in tanneries, the possibility of reintroducing it in leather processing was studied, but also capturing it in a complex of residual minerals (Pontikes *et al*., 2009), with the possibility of accumulating on this complex to produce ceramic glazes and glass (Wang *et al*., 2007). Chromium has different effects on organisms. The effect of chromium accumulation on aquatic life - fish - is not known, but high concentrations of metals from spills can damage gills as well as fins. For the animals, it can cause respiratory problems, birth defects, infertility, tumors. It is beneficial for crops to contain controlled amounts of chromium because the plants absorb chromium III from the environment. Cancer occurs 15-30 years after the first exposure of the body, by localization in the organs, chromium causes malignant tumors. The health risks of chromium depend on its oxidation state. Metallic chromium has low toxicity. Chromium III is beneficial for health but within certain limits. Chromium VI is toxic.

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The toxicity of chromium is well known and a suitable way for its removal is desired. One solution is to use the chromium leather waste ash, together with a mix of polymeric products made from bisphenyl A (BPA) and bisphenol F (BPF) to obtain traffic floors or decorative plates for buildings and other. Bisphenyl A was discovered in 1891 by the Russian chemist Aleksandr Dianin and in 1958 the polycarbonate plastics were discovered by the Bayer and General Electric (Rengaraj *et al*., 2003). From all the BPA produced, 65-70% go to the polycarbonates production (Park *et al*., 2008; Turtoi *et al*., 2001), 25-30% is used for epoxy and vinyl ester resins production (Rengaraj *et al*., 2003; Park *et al*., 2008) and 5% is use in the manufacture of high-performance plastics and as a minor additive in PVC, thermal paper, and several other materials. Bisphenol F (BPF) is used in plastics and epoxy resins production as tank and pipe linings, bridge deck toppings, industrial flooring, structural adhesives, electrical varnishes and several other materials (Arthanareeswaran *et al*., 2007). It is used in obtaining liners, lacquers, adhesives, coating of drinks and food cans (Arthanareeswaran *et al*., 2007). BPF is used in dentistry as restorative materials, adhesives, oral prosthetic etc. (Arthanareeswaran *et al*., 2007). The final product can be obtained if a curing agent is present. Ancamine 2686 is a proper candidate that can operate at room temperature for liquid epoxy resin. Ancamine 2686 provides high mechanical build and very good chemical and mechanical resistance (Strathman, 1980). Quartz is a mineral substance (silica oxide) naturally found in nature. Depending on the granulation, this one can be use as filer in the main composition, to bring more “light”. By exploiting its piezoelectric properties, the polymeric floor can incorporate some devices that can generate electricity.

EXPERIMENTAL

Materials

Bisphenyl A (BPA), IUPAC name 2,2'-bis (4-hydroxyphenyl) propane – organic compound, solid, colourless, melting point 158-159°C, with a good solubility in organic solvents and poor solubility in water.

Bisphenol F (BPF), IUPAC name 4,4′-dihydroxydiphenylmethane – organic compound, solid, melting point 162-164°C, with a good solubility in organic solvents.

Ancamine 2686 – organic compound, liquid, yellow, 100-400 mPa·s at 25°C.

Quartz (Uricani) – is a mineral substance (silica oxide) – 99,99%.

Chromium leather ash – 61% Cr_2O_3.

Figure 1. Materials

Equipment

Hot plate – Magnetic Stirrers with Hot Plates (Velp Scientifica) with 50-370°C temperature interval. Oven – (Nabertherm) with 50–1200°C temperature interval.

Ultrasonic bath – Elmasonic S 15H (Elma) – with 30 – 80°C interval and 01-30-∞ min variable time setting.

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Stereomicroscope – S8AP0 (Leica). Magnification is from 10x to 160x, it has incident and transmitted light and possibility to observe the samples with polarized light.

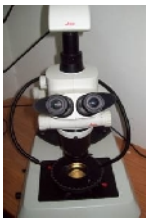
Durometer – device specially designed to measure the hardness of materials such as polymers, elastomers, and rubbers. The Shore A Hardness Scale measures the hardness of flexible mold rubbers that range in hardness from very soft and flexible, to medium and somewhat flexible, to hard with almost no flexibility at all.

Micro hot table is a device that has the possibility to heat with a preset speed, allowing to visualize the sample behavior, from the upper part of the equipment, with the help of a stereomicroscope.


Hot plate


Oven


Ultrasonic bath


Optical stereomicroscope


Micro-hot table


Durometer

Figure 2. Equipment

RESULTS AND DISCUSSIONS

For this experiment, tanned leather waste was used (Figure 3-a), subjected to heat treatment, in stages. The chromium leather waste was initially treated at 150°C in order to burn the organic part, resulting in a carbonized waste (Figure 1-3). After this process, chromium leather waste was heated at 800°C to eliminate all the organic parts (Figure 3-c).


a) Leather waste


b) Leather waste at 150°C


c) Leather waste at 800°C

Figure 3. Leather waste in different stages

Based on obtained chromium ash, a number of 8 recipes were developed – Table 1.

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Table 1. Components used for epoxydic samples

No.	Chromium leather ash	Epoxydic resin	Hardener	Uricani quartz
		%		
1	-	40.00	20.00	40.00
2	0.10	39.96	19.98	39.96
3	0.20	39.92	19.96	39.92
4	0.30	39.88	19.94	39.88
5	0.40	39.84	19.92	39.84
6	0.50	39.80	19.90	39.80
7	0.60	39.76	19.88	39.76
8	1.00	39.60	19.80	39.60

The quantities of each recipe specified in the Table 1 were placed in a cylindrical plastic container to facilitate mixing, which was later used as a mold for the final sample. The components from each container were subjected to mechanical mixing (manual) – 3 min, ultrasonic mixing (with degassing) – 20 min, mechanical mixing (manual) – 3 min, rest – 1 h.

After the synthesis, discoidal samples were obtained, illustrated in Figure 4.

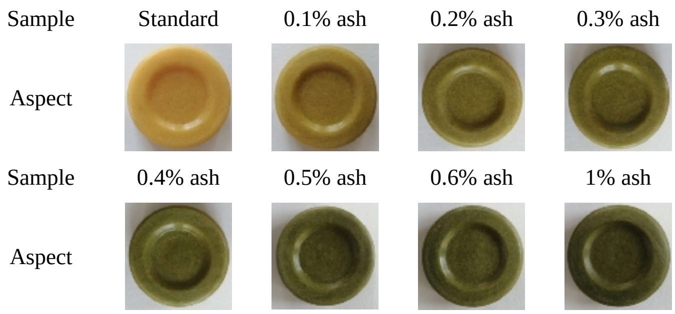

Figure 4. Composite materials base on leather waste ash

After synthesis, all the samples were subjected to a series of tests, to obtain relevant data for characterisation. Microscopy test reveals that all samples are homogeneous for the entire surface and areas with component segregation are not visible. At the same time, the same test shows that the samples contain air bubbles – Figure 5.

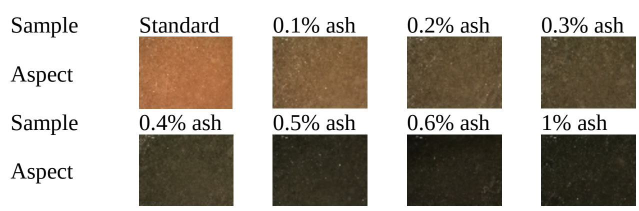

Figure 5. Microscope aspect of composite materials base on leather waste (20x)

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The height of the obtained samples was between 0.81 and 0.86 cm, area between 42.08 and 43.01 cm^2. Based on these values, sample density is between 0.2675 g/cm^3 and 0.2813 g/cm^3. After a mathematical conversion, it follows that 1 m^2 decorative plate with a height of 0.8 cm will have an average weight of 2.3 kg. The values can be observed in Figure 6 (obtained samples) and Figure 7 (calculated decorative 1 m^2 plate).

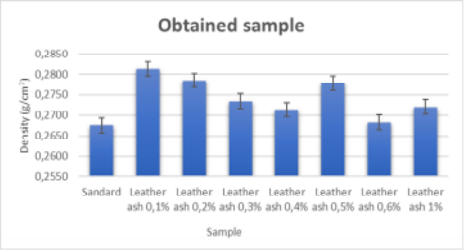

Figure 6. Sample density (g/cm^3)

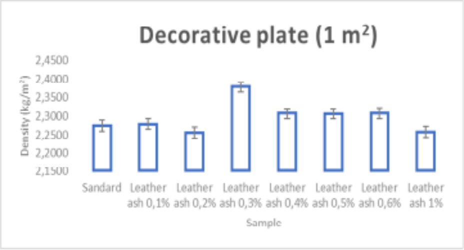

Figure 7. Plate weight (kg/cm^2) for a plate with 0.8 cm thickness

Obtained samples were tested also for hardness, and values registered were between 93°ShD and 96°ShD, on a scale of 0-100 (Figure 8).

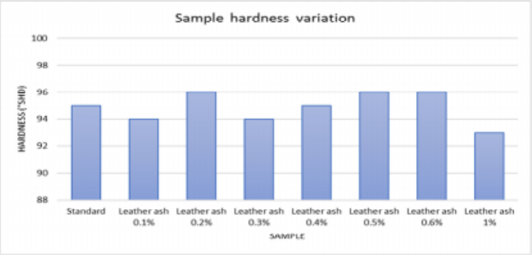

Figure 8. Sample hardness (°ShD)

CONCLUSION

Chromium leather waste can be used as raw material in a different product, and by embedding it in a proper matrix is possible to prevent its potentially toxic action on the environment.

By using a polymeric material, it is possible to obtain decorative plates that can be used in constructions. The obtained decorative 1 m^2 tiles have an average weight of 2.3 kg, which means that they will not create an additional problem for the facade of the buildings.

Due to the high hardness of the obtained samples, over 93°ShD, the obtained material can also be used as traffic floor.

In the same way special protective paints for corrosive environments, cast parts and / or processed by various technologies can be obtained, as well as other applications in various fields (art, aeronautics, consumer goods).

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