Analysis and Characterization Of Ceramic Re-Covering With Polymeric Materials

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Abstract

The constant necessity to improve the quality of re-coverings, through new finishing methods and colors, for example, has favored the development of new techniques that allow the achievement of effects that were, until a few years ago, difficult to obtain through the utilization of traditional enameling techniques. In this work the feasibility for the use of polymeric materials on ceramic surfaces was investigated, as an alternative to using enamels, traditionally utilized by industries in this sector. Aiming to obtain a more detailed knowledge about the behavior of the polymeric material, several types of experiments were carried out to evaluate the useful life of this material when subjected to normal conditions of use. Among these are: visual and superficial analysis, ozone and, ultraviolet attack (UV), saline chamber and, acid chamber experiments and the freezing test. The results obtained indicated that the use of this new technology results in a material with very promising characteristics.

Keywords: polymers, ceramic surface, ceramic materials, ozone and ultraviolet attack, re-covering technology.

Introduction

In recent years, great importance has been given to the search for new methods that offer greater benefits for the production and quality of manufactured products [6], due to the increasing interest demonstrated by the market and manufacturers in recently proposed esthetical solutions in relation to the development of new enamel formulations [7].

With the advance of enameling and decoration technologies [8], coupled with the expansion of polymer industries, new uses and technologies for these materials are coming out at surprisingly speed.

With this evolution, a lot has been done to improve the existing techniques, products and equipment utilized by the polymer industries. As a result, polymers have been quickly replacing traditional materials such as metals, wood and glass in many areas of application [9].

In some applications the replacing is immediate, but in other cases it is necessary to determine exactly the type of polymer that should be utilized, the best process for obtaining it and which technical characteristics must be considered in order to gain a practical notion of its real applications [4].

Considering the importance of the current production and enameling technologies of ceramic re-coverings, this study reports objectively a general view regarding the potential for polymeric materials utilization as an innovative alternative to ceramic re-covering aiming to obtain products with differentiated characteristics, and also investigate the possibility to eliminate some processing steps.

Materials and Methods

The acrylic polymer utilized in this work was selected according to its functional properties, such as good resistance to atmospheric agents, stability in the presence of light, excellent transparency, wide capacity for coloring, good resistance to high and low temperatures and to abrasion.

The polymeric covering solution was prepared by dissolving acrylic polymers in 100 ml of hot organic solvent (90°C). After, 0.4g of dye was added. The polymeric covering was then applied to the ceramic piece at room temperature utilizing an automotive painting pistol with lower feed.

The surface analysis of the ceramic samples before and after re-covering with the polymer was carried out by Scanning Electronic Microscopy (SEM) with a Philips microscope, model XL 30, with a tungsten filament coupled to an energy disperse X-ray spectrometer (EDS) and by optical microscopy.

The thickness of the polymeric layer was also determined by image analysis.

The saline chamber experiments were carried out by exposure to saline haze, as described in the NBR 8094 standard method [02].

The acid chamber experiments of the ceramic samples were carried out as described in the NBR 8096 standard method [03].

The ozone and ultraviolet (UV) attack experiments were carried out as described in the ANSI/ASTM G 53 standard method [01].

The freezing test was carried out using a test sample with the dimensions 15 x 15 cm, which was put in a freezer and exposed to a temperature of approximately -18° C for a period of 24 hours.

In the resistance to heat experiment the test samples used had the same dimensions described in the freezing test. The samples were placed in a DE LEO oven (model 799) for a period of 24 hours at temperatures of 50, 80, 100, 125 and 150°C.

Results and Discussion

Regarding the surface analysis, it can be observed from the micrograph shown in figure 1 that the ceramic sample without covering has a very irregular surface.

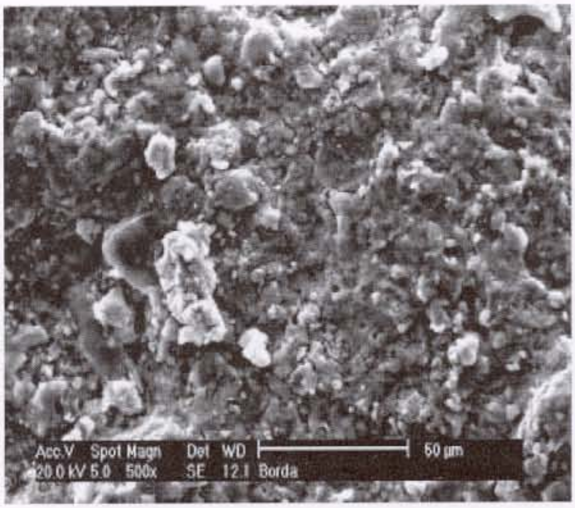

Figure 01. Micrograph of the ceramic surface without polymeric

However, after the re-covering of the sample with the polymeric material (figure 2), it was verified that the ceramic surface had a better superficial finish, and a good adherence of the covering to the ceramic support was observed.

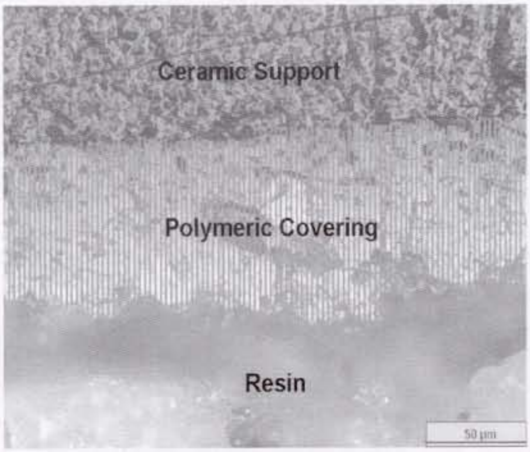

Figure 02. Micrograph of the ceramic surface re-covered with polymer

Nevertheless, it was observed that the polymeric layer did not have a constant thickness for the same region analyzed, which can be confirmed through figure 3 where a variation in the thickness between 72 and 102 µm was verified.

With regard to the thickness of the polymeric layer, it was verified through analysis carried out by optical microscope for the standard sample (figure 4) that the material used in the covering of the ceramic surface was not uniformly distributed. Some darker regions were observed, indicating the occurrence of polymer accumulation on the sample, which is consistent with the results presented in the figure 3.

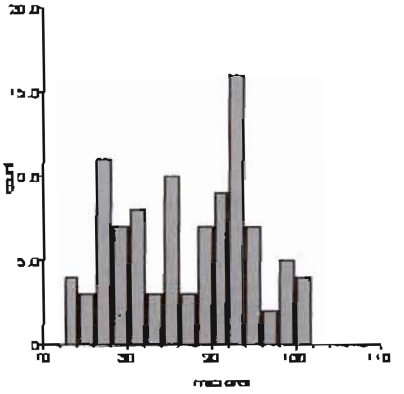

Figure 03. Graphic of the polymeric layer thickness.

This variation in the thickness of the polymeric layer may be due to operational problems, possibly resulting from the mode of application, which could be resolved by using an automatic mechanism.

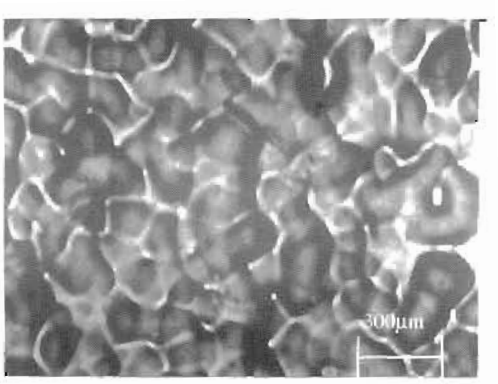

Figure 04. Micrograph of the ceramic surface re-covered with polymer.

In the experiments carried out in the saline and acid haze chambers, no visible effect in the material surface was observed after the tests, indicating that this material is suitable for places with conditions such as those in the marine atmosphere, as well as in corrosive environments.

In the ozone and ultraviolet (UV) attack experiments, we could observe that one of the main sources of the polymer degradation is ultraviolet radiation. However, the analyses performed, showed that the material studied is not photo-oxidatively degraded when irradiated by ultraviolet light and ozone. This means that there is no absorption of this radiation by specific groups of the polymer which could cause an increase in the electronic excitement, and result in molecular rupture of the polymeric chain at more susceptible sites [9]. It should be mentioned that crackles or tonality changes in the material after 15 days of experiment were not observed.

In the freezing test, no damage to the polymeric layer (crackles, fading in the covering) was observed after 24 hours of exposure.

For the resistance to heat experiments performed at temperatures of 50, 80, and 100°C, significant changes were not observed in the polymeric covering. However, at 125°C, bubbles in the polymeric layer after 30 minutes of exposure were verified. In the experiment performed at 150°C, total degradation of the polymer was verified after 10 minutes. According to Rabello [6], when the thermal energy added to the system is higher than the intermolecular bond energy, a rupture of the chemical bond occurs due to temperature effects (thermal degradation). It should also be mentioned that thermal stability is a characteristic of polymers and it depends on the nature of the chemical groups presented which define the energy of bond dissociation.

Regarding the esthetical characteristics, the superficial aspect is considered one of the more important characteristics of ceramic re-covering [5] and to keep this characteristic within a narrow range of variation, an effort to reduce the problem of tonality variation is necessary. Therefore, the use of polymers in re-covering ceramic surfaces has made it possible the to obtain a wide multiplicity of strong tonalities that are difficult to obtain through traditional enameling techniques. Along with this, it should be mentioned that this technique has the advantage of ease of color reproduction, from the combination of a reduced number of dyes.

Economic aspects are important in the use of this new re-covering technology, since when ceramic is submitted to re-covering it does not need to receive an engobe layer before the covering, to minimize defects coming from the mass, to propitiate a good agreement mass glass and also background color homogeneity, when the mass varies tonality a lot [5].

Additionally, there is the reduction in the number of steps necessary to obtain the final product, because the utilization of this type of re-covering eliminates a second burning for special effects leading to a reduction in the production costs. Since there are problems caused by the tonality variation of the enamels, it is important that that utilization of such polymeric materials in ceramic surface re-covering allows the minimization of these variations.

Conclusions

The results of the experiments carried out indicated that the material utilized presented a good resistance to weather changes, and to ozone and ultraviolet attack. Analyses carried out have also shown that it is possible to obtain a covering with constant thickness, when adequate changes are made regarding covering application, for example, the use of another type of pistol without the need to alter the studied formulation. It should also be mentioned that the technology of re-covering ceramic surfaces with polymeric materials is a very promising technique, which makes it possible to obtain a product with very attractive characteristics, directed to little explored markets. The considerable economy associated with the process adds a stimulus to continue this research in order to obtain more information regarding the wider application of this new re-covering technology. However, the use of this type of material is restricted to building front re-coverings only.

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