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Study of PVDF/PMMA blend resistance to artificial aging and neutral spray

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Abstract

The resistance of poly (vinylidene fluoride)/poly (methyl methacrylate) (PVDF/PMMA) blends was investigated using the artificial aging and neutral salt spray tests. The solution of each polymer was prepared using the N, N-dimethylformamide (DMF) as a solvent for the two polymers. The PVDF/PMMA blend is a compromise of a great development in the field of architectural preservation, since it is the best method in term of quality and price to make new polymeric materials having enhanced properties. The addition of PVDF to PMMA enhances the properties of this last to know the exhibition in the natural and artificial ageing and to the saline fog. The results showed that the exposure of coatings to artificial aging and to the salt water vapors showed a high resistance of the blend at compositions ≥ 70 of PVDF/PMMA.

Keywords: PVDF, PMMA, coating, artificial aging, neutral salt spray.

1. Introduction

Materials have always defined the level of development of our civilization [1], among other polymeric materials that have shaken much the habits of industry and those of consumers that the time since the eighties , the global production of plastics exceeds in volume that of metals .

Today, polymeric materials are present in all areas of human activity [2], from the packaging to the interplanetary rocket; among their various applications include the restoration and preservation of historical monuments (ruins, sculptures, paintings...).

In general, the fluorine substitution of the hydrogen atoms present in a macromolecular chain improves the heat resistance and chemical resistance, delays or inhibits flame propagation, lowering the critical surface tension and exalts the dielectric characteristics.

However, the stability of fluoropolymers is the key factor in their usual performance [3]. Acrylic resins undergo deterioration face conditions under UV radiation [4]; therefore their use as agents for the protection of stone is limited. Their climatic exposure causes degradation of their structure as well as serious damage to the stone.

For this reason, acrylic resins are now less used in the conservation of historic structures exposed to atmospheric agents. However, their physical characteristics and their low price always consider an important research topic in the protection of the stone. On the other hand, the fluoropolymers present a good chemical inertness and well UV resistance [5].

In our work, the focus was on the development of films based blends of PVDF and PMMA who underwent exposure to artificial weathering and salt spray. The PMMA has a good optical property and rigidity; this is the best organic glass. It can easily be colored, as used as safety glass for aircraft (transparent domes) and as optical glass [6].

2. Experimental

PVDF designated Hylar 5000, special coating as a white powder, manufactured by Ausimont, Italy was used as received. PMMA designated Vedril ® Spa (Resina Metacrilica) made by Mont Edison, Italy was used as received. The PVDF/PMMA films were obtained by casting each polymer separately in the

DMF at 70°C at different weight contents (0, 10, 20, 30, 40, 50, 60, 70, 80, 90 and 100 wt %).

Exposure of coatings to artificial aging (fluorescent UV and water) according to standard ISO 11507: 1997 (E):

Artificial aging of the paint coating and subjected to condensation to ultraviolet fluorescent lamps is performed to obtain a degree of modification of one or more properties, after a light exposure or a mutually agreed upon total number of hours test. An accelerated Weathering Tester Q. PANEL COMPANY as test chamber was used. Ultraviolet light is emitted from a UV mercury arc lamp, low pressure with wavelengths between 270 and 400 nm, alternating cycles and 4 hours. Knowing that a cycle contains 500 hours and is equivalent to an outdoor exposure (natural aging) a year; and a temperature of up to 50 ° C.

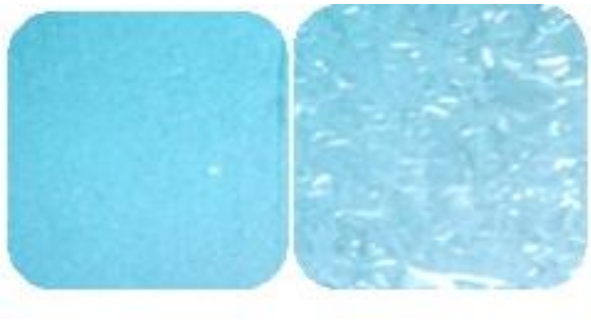
Resistance determination to neutral salt spray test according to ISO7253: 1996(E):

The test solution should be prepared by dissolving sodium chloride in water as defined in ISO 3696 to give a concentration of (50 ± 5) $g.m^{-3}$. The measured temperature inside the spray chamber should be (35 ± 2) ° C; with a heating temperature of 55 ° C. The average recovery rate of the sprayed solution, measured over a minimum period of 24 h is 1 ml per hour to a horizontal collector surface area of 80 cm^2.

3. Results and discussion

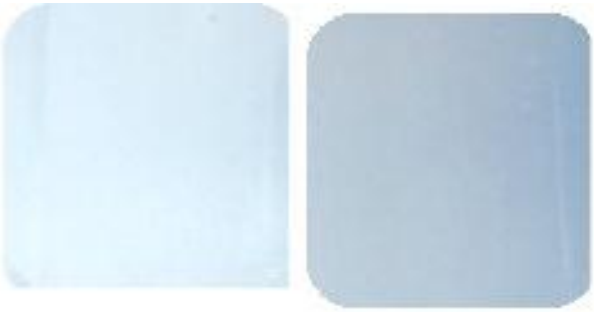
Coatings Exposure to the artificial aging

The table 1 shows the variation the artificial aging resistance of the different compositions of the PVDF / PMMA blend, it is noted that the PVDF (100/0) film exhibits an excellent resistance to accelerated aging on a period of two years (> 17,000 hours) at 50 ° C and an UV radiation between 270 and 400 nm; and the same for 90 /10, 80/20 and 70/30 compositions.
The PMMA (0/100) film has cracked and the resistance of the other of compositions was good, medium and bad one.



(a) (b)

Figure1. Artificial aging resistance of the different compositions of the PMMA; (a) Reference film, (b) Film after exposure to artificial ageing.



(a) (b)

Figure2. Artificial aging resistance of the different compositions of the PVDF; (a)Reference film (b) Film after exposure to artificial ageing

Table 1. Artificial aging resistance of various compositions of PVDF /PMMA blends

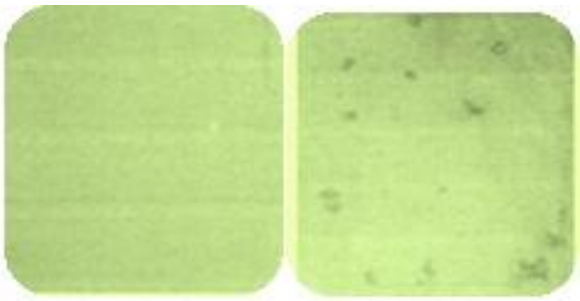
PVDF (%)	0	10	20	30	40	50	60	70	80	90	100
Film resistance	5	4	4	2	2	2	3	1	1	1	1

1 Excellent film resistance, 2 Good film resistance, 3 Medium film resistance, 4 Bad film resistance and 5 Film cracking.

Coating exposure to the neutral saline fog

Table 2 shows the variation of neutral saline fog as a function of different compositions of PVDF/PMMA blends, it is observed that pure PVDF samples give an excellent film resistance to the saline vapors under a pressure of 70 to 170 KPa at 35°C. The same results are also available for 90/10, 80/20 and 70/30 PVDF/PMMA fractions.
Pure PMMA films (0/100) present a medium resistance. Regarding the remaining compositions, the

resistance evaluation varies between good, medium, bad and total corrosion of the plate.



(a) (b)

Figure3. Neutral saline fog resistance of the different compositions of the PMMA; (a) Reference film, (b) Film after exposure to neutral saline fog

(a) (b)

Figure4. Neutral saline fog resistance of the different compositions of the PVDF; (a) Reference film, (b) Film after exposure to neutral saline fog

Table 2. Resistance to neutral saline fog at different compositions of PVDF/PMMA blends.

PVDF (%)	0	10	20	30	40	50	60	70	80	90
Film resistance	3	4	5	4	3	2	3	1	1	1

1 Excellent film resistance, 2 Good film resistance, 3 Medium film resistance, 4 Bad film resistance (plate corosion) and 5 Total plate corrosion.

Conclusion

From the different results obtained, it can be concluded that:

- The exposure of coatings to artificial aging (fluorescent UV and water) showed a high resistance of the blend at compositions ≥ 70 of PVDF/PMMA.
- The coating exposure to the neutral saline fog showed that the PVDF has an excellent resistance to salt water vapors at compositions ≥ 70 of PVDF/PMMA.

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