Compositional variations of polymers used in conservation. Study by ATR-FTIR spectroscopy of changes promoted by UV radiation.

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INTRODUCTION

Many synthetic polymers are used in Cultural Heritage Conservation (storage, packaging, exhibition, treatments conservation, etc).] However, in general, they have other industrial uses and they haven't been developed for specific use in the conservation of works of art area. For this reason, it is indispensable to carry out some preliminary studies related to analytical characterization and their long term behaviour, also it is very important know the nature of the additives used in their processing.

One of the consequences of the degradation of polymers is its yellowish, associated to the corresponding processes of oxidation (normally photo-oxidation). This effect caused the formation of carbonyl group (C=O) (chromophore). The presence and the increase of this group in the chemical structure represent yellowish degree of the material.

EXPERIMENTAL

MATERIALS

Two kinds of neutral foam core board (composite material): Polyestyrene (core) and cardboard (external face)

SAMPLE PREPARATION FOR AGING

Support: aluminium tray

For each polymer: three (2.5X5cm) samples were prepared for Xenon irradiation and two samples (7x20cm) for UV irradiation

Black cardboard: kept the samples to the same temperature inside the camera and it avoids the radiation (covering the half of the surface)

SAMPLE PREPARATION (ATR-FTIR AND COLOR)

Samples were examined directly in the solid

AGING INSTRUMENTS

- Xenon-Arc camera Suntest XLS. $\lambda \geq 295$nm.Radiation 765 W/m2. T_{max}=45° C. Window glass within 3mm thick glass (inside museums or stores)
- UV-light: prototype UNE 53-104-86. Fluorescent lamps Ultraviolet-B TI 40W/12RS

EQUIPMENT : Konica Minolta Chroma Meter (CR 2600d). Diffuse illumination. 3 mm-diameters measuring. CIE ab determination.

ATR-FTIR spectrometer (Thermo Nicolet 380) with a DTG. 4000-400 cm^{-1}. Diamond (ATR). Absorbance mode. 64 scans at 4 cm-1 resolution.

METHOD

	COLOUR	ATR-FTIR
MEASUREMENT	6	6
SPECTRA	6	6

Carbonyl index ($I_{C=O}$): [$I_{C=O}=(I_{1720}/I_{695}).10$]

I_{1720} =absorption band at 1720cm-1 ($\nu_{C=O}$)

I_{695} =standard band at 695cm^{-1} ($\delta_{wagging}$ C–H $_{aromatic\ ring}$)

IRRADIATION	XENON-ARC	UV
CICLES	120h exposure + 24h darkness	528h exposure
	240h exposure + 48h darkness	
MEASUREMENTS	48h exp,96h exp, 120h exp+ 24h dark 264h exp+ 24h dark, 360h exp+ 24h dark and 360h exp+ 72h dark	24, 48, 72, 96, 216,352, 432,and 528h

RESULTS

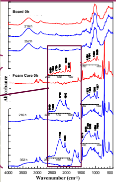
UV RADIATION

No chromatic variation

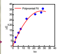
Increase of C=O band

CIE ab (yellowish)

FOAM CORE BOARD A

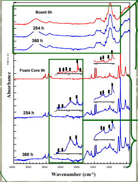


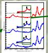
Chromatic changes foam core (polystyrene)



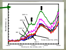
Arc-Xenon RADIATION

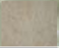
FOAM CORE BOARD B



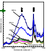


Presence of C=O band

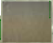




Yellowish of board. Board image; fibres (containig lignin)



No exposed sample



Exposed sample

Conclusion

The ATR-FTIR spectra corresponding to the polystyrene foam of the two aged foam core board (archival quality) show noticeable changes after UV radiation aging . The Arc Xenon irradiation are less shocking but they are on the same line of degradation.

The chromatic variation is confirmed with color measurements, these show yellowish. The polystyrene degradation is recognised by effects on the appearance and properties of the material (yellowish and crazing and chalking of the surface)

The UV radiation of the board of the foam core board A presents no evidence of changes, but the arc-xenon radiation of the foam core board B presents a chromatic variation. The explanation of this different behaviour is the chemical composition of the two boards. Both of them present cellulose and calcite but the B kind present, as well, lignin.

Acknowledgements

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