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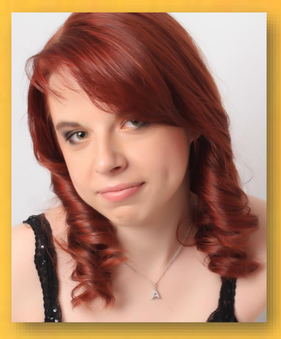

Defining light stability of plastics in heritage collections

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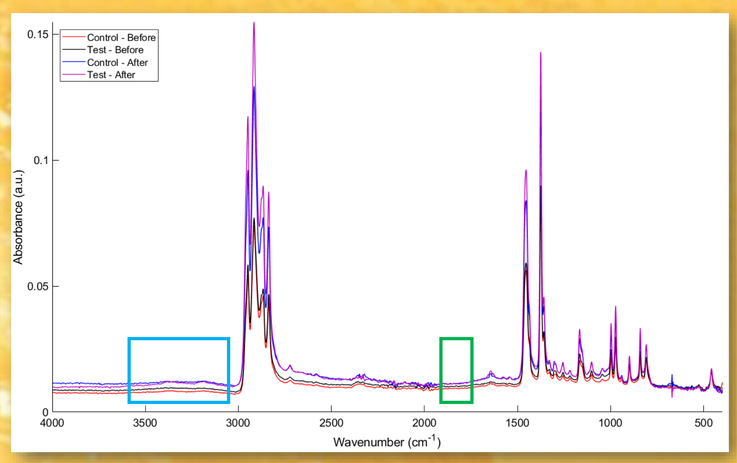
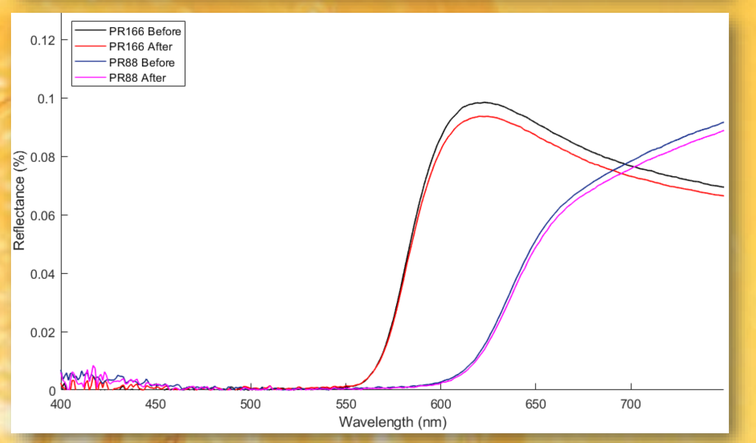
Introduction

Despite their relatively short history synthetic and semi-synthetic materials have very quickly penetrated every facet of modern society. The incredible versatility of plastics has enabled artists and designers to express their creativity like never before. Even everyday objects are fast becoming heritage due to the way they completely transformed how we live our lives. Plastics have become ubiquitous, however our knowledge of their longevity is still lacking, particularly with regards to the stability of plastic artefacts in museums. This especially applies to their relationship with visible light as opposed to UV radiation so often used in accelerated degradation tests. This lack of evidence leads to missing or vague display guidelines for plastics in collections.

This project looks at the effect of visible light on plastic artefacts in the context of a museum environment. The main goal is to identify components in plastic formulations that could increase sensitivity of the material to visible light.



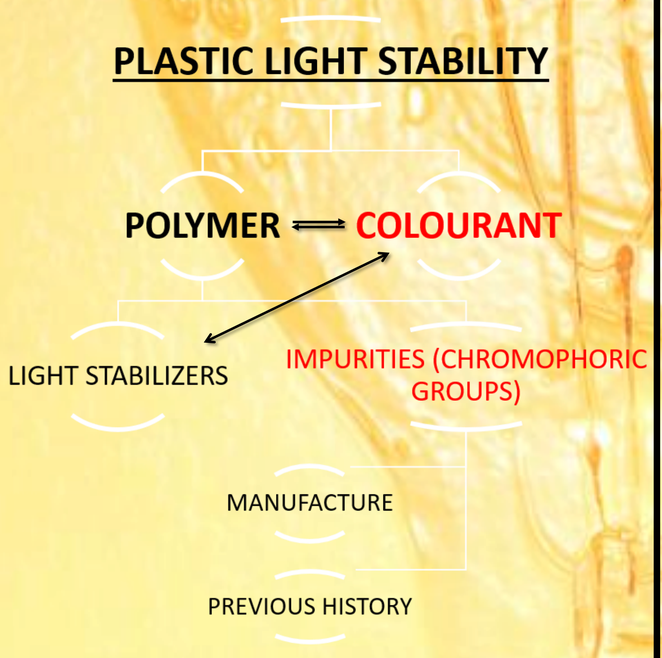
FTIR spectra of aged and unaged samples of unpigmented PP showing no changes after ageing in the hydroxyl (blue box) or carbonyl (green box) regions which would indicate photooxidation of the polymer.



Visible reflectance spectra of the two red PP samples showing no shifts in the reflectance curves which would indicate colour change of the materials after ageing.

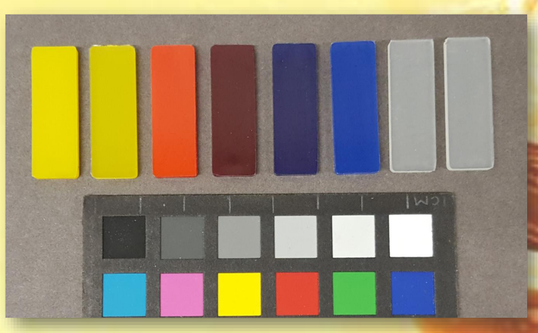
Experiment

Four different components were first identified as having the strongest influence over the light stability of a plastic (right). Next, those which absorb visible light were prioritized, with colourants as the focus of the first experiment as they can have either a stabilizing or sensitizing effect in a plastic formulation.



Pigments previously found to be sensitizing when exposed to UV were selected from literature and exposed to intense visible light (λ > 400 nm) for 4 weeks at ambient conditions. The total irradiance was 8.6 Wh/cm^2 which corresponds to a light dose of 12.23 Mlx h.

The first experiment of the project included samples of injection moulded unstabilized polypropylene (PP).



PP samples used in the first experiment. From left to right: PY95, PY83, PR166, PR88, PB15:1, PB29, unpigmented PP.

	Additives															
	PB15:1	PB29	PR88	PR166	PY95	PY83	PY154	PY42	PY35	PY14	PO13	PR48:2	PV23	PR52:2	DEP	HALS
Polypropylene	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓			✓
Cellulose Acetate		✓						✓	✓		✓	✓	✓	✓	✓	

Table of materials selected for the study. The red box highlights samples tested in the first experiment.

Analysis & Results

The experiment was repeated with identical samples and conditions in order to validate results and material stability was assessed with ATR-FTIR and Visible-NIR Fibre Optic Reflectance Spectroscopy (FORS).

FTIR analysis of both pigmented and unpigmented samples showed no changes in the hydroxyl and the carbonyl regions where new peaks should appear as hydroxyl, hydroperoxide and C=O groups are formed through photooxidation of the polymer.

There was also no evidence of degradation in the visible reflectance and NIR spectra of any of the samples.

Future Work

Identification of any pigments that could sensitize PP or CA to visible light exposure would allow conservators to make better informed decisions regarding the display of plastics that contain them.

The first set of pigments tested in the project did not induce degradation of PP after exposure to intense visible light when no other additives were present. The following experiments will investigate the influence of other colourants on PP as well as cellulose acetate (CA). Synergistic effects with light stabilizers for PP and plasticizers for CA will also be explored.

At the same time, the question of the influence previous exposure history of an object before entering museum collection will be addressed by looking at the induction period in polymer degradation. Samples will be pre-exposed to a small dose of UV (300-400 nm) before accelerated visible light degradation.

Acknowledgments

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