The fate of colors in the 20th-21st centuries: preserving organic colorants in plastic artefacts

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Photodegradation may cause irreversible colour changes (e.g. fading, blanching) in works of art. Whereas photochemical studies for paper, textile, wall paintings, canvas and panel paintings have been reported, the behaviour of chromophores in plastics is less often discussed. Although several plastic objects in museum collections have already lost their original colour, the colorants and photochemical mechanisms responsible for the fading have not been completely investigated.
My doctoral thesis in *science for conservation*, started in 2016 at DCR FCT-UNL and it aims to investigate the discoloration of organic colorants in plastic artefacts. The project includes the develop of innovative multi-analytical methods for the molecular characterization of the colorants along the insight into the photodegradation mechanisms responsible for the colour alteration trough photophysical studies. On one hand, the identification of the colorants represents the first and a fundamental step in supporting the conservation of plastic artworks. In fact, the chemical structure of chromophore and its chemical surrounding play a key role in assessing the stability of colorants in plastic. On the other hand, the fundamental photophysical properties of the colorants offer a first rationale for their light-induced degradation providing new insights into their photochemistry.
In this work, preliminary results of colorant characterization in Portuguese collections by using in situ molecular and elemental techniques (without micro-sampling) are presented. The multi-analytical approach includes optical microscope observation, μ-EDXRF, UV-Vis-NIR reflectance spectroscopy, TR FT-IR, Raman and luminesce studies. The potential, efficacy and limits of the methods used will be discussed together with consideration of the inherent complexity of the system studied. In fact, in situ characterization represents a methodological and analytical challenge because of the very small amounts of colorants used (0.5%-5%). In addition, first overview of the photophysical properties of the specific class of colorant β-naphthols is discussed. The historical interest for β-naphthols, substituted 1-arylazo-2-naphthols, is well documented being one of the first classes of colorants to be synthetized and used in plastics and artworks from the beginning of the twentieth century. Trans-cis photoisomerization, azo-hydrazone tautomerism and ESPT are reported along first quantum yield of photodegradation. The building-up methodology of photophysical studies (from homogeneous (solvents), heterogeneous (transparent gel) to solid media (casting solution of PMMA)) is also discussed representing the first systematic study of β-naphthols photochemical proprieties.