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Studies towards Lightfast Automotive Dyes for Polyester

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ABSTRACT

This paper provides an overview of studies conducted in our dye chemistry laboratories that were directed towards the design, synthesis, and evaluation of dyes for polyester fibers for applications requiring high lightfastness. Presented are results from the early studies in our program that involved characterizing the chemistry associated with the light-induced (photo) degradation of azo, anthraquinone, and nitrodiphenylamine disperse dyes in an ester environment. This is followed by a summary of molecular design efforts based on results from dye photodegradation experiments. In this case, results pertaining to the utility of built-in photostabilizer groups for enhancing disperse dye lightfastness (resistance to light-induced fading) are discussed. Special attention is given in this paper to studies in which the effects of natural and artificial light on oriented polyester films following the application of azo, anthraquinone and nitrodiphenylamine dyes were assessed. This work was part of an investigation aimed at determining the contribution of polyester to the fading of disperse dyes. In this regard, dyed polyester films were exposed to sunlight from two regions in the United States and to the artificial light of an Atlas Weatherometer. The results of the different exposures indicate that artificial light exposures were far more damaging to the polymer host than natural light. It was also apparent that a significant level of dye fading could be attributed to substrate degradation.

Keywords: dye, fading, lightfastness, polyester films, exposure

1. Background

It is both ironic and unfortunate that the very types of processes responsible for the colors we see on textiles are also responsible for their demise when the adsorbed dyes are exposed to sunlight for prolonged periods. Color is seen whenever an object absorbs light of a given wavelength in the visible region (400-700 nm) of the electromagnetic spectrum and reflects the remaining incident light to our eyes. The colors we perceive as a consequence of these processes are summarized in Figure 1[1]. Note that the colors seen are complementary to the one absorbed. Invariably, organic compounds, including the colorants used to dye textile fibers, also absorb light in the ultraviolet (UV) region (200-400 nm). See, for example, the Pisystem[2] calculated absorption spectrum for Disperse Blue 14 in Figure 2, where the absorption at 600 nm is responsible for color and those at 324 nm and 385 nm probably contribute most to fading since window glass filter systems typically give a 310 nm cut off.