Light Stabilizers
Gerhard Rytz*, Jean-Luc Birbaum, and Alfred Steinmann

Abstract. Current trends in the light stabilization of polymers and coatings are summarized, with emphasis on UV absorbers and free-radical scavengers.

1. Introduction
Light and oxygen cause photo-oxidative reactions in polymer materials and, as a consequence, a change of their visual aspect and of their physical and mechanical properties. Light stabilizers (photostabilizers, UV stabilizers) are additives which retard or prevent such detrimental processes [1][2]. Their technical and economical significance is impressive, since they do not only improve the quality of most polymer products, but also contribute to new applications and technologies. Depending on the inherent light stability of the substrate to be stabilized and its application, light stabilizers are applied in concentrations between 0.05 and 2%. The light stabilizers are selected from the following classes:
- UV absorbers and light screeners
- free-radical scavengers
- hydroperoxide decomposers
- quenchers

2. Synthesis and Characterization of Novel UV Absorbers
The most commonly used UV absorbers are 2-(2-hydroxyphenyl)-1,2,3-benzotriazoles (HBT) 1. A wide range of commercial HBT is available. Collaboration with the University of Stuttgart (Prof. H.E.A. Kramer) has recently broadened theoretical insight into protection mechanisms of HBT [3]. The absorption of an UV photon leads to a singlet excited state undergoing an intramolecular proton transfer which is of fundamental importance. Internal vibrations

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[1] D. A. Jones, 'Principles and Prevention of Corrosion', Macmillan Publishing Comp., New York, 1992.
[2] J. S. Robinson, 'Corrosion Inhibitors Recent Developments', Noyes Data Corp., New Jersey, 1979.
[3] W. Funke, J. Coat. Technol. 1983, 55, 31.
[4] A. Brait, '68th Annual Meeting and 55th Paint Industries', Show of the FSCT, October 29–31, Washington, 1990.
[5] W. J. Bartz, 'Additive für Schmierstoffe', Expert Verlag, Renningen, 1994.
ther oxidized by oxygen to ferrous(III) hydroxide: rust.

For rust inhibition, preferred compounds are those containing a highly polar group with a long alkyl chain. Structures of this type have a strong affinity for metal surfaces and can form dense hydrophobic protective films.

In addition to the simple fatty acids, the half ester and half amid form of dodecenyl succinic acid (Irgacor L 12) have been widely accepted as rust inhibitors.

4. Conclusions

Today, there is increasing pressure on paint manufacturers to phase out solvents and heavy metals from all types of paint. Accordingly, new corrosion inhibitors are required in order to give water-borne paints the same performance as solvent-based coatings. To fulfill these requirements, a new class of environmentally acceptable corrosion inhibitors for aqueous paint systems is under development.

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[1] D. A. Jones, 'Principles and Prevention of Corrosion', Macmillan Publishing Comp., New York, 1992.
[2] J. S. Robinson, 'Corrosion Inhibitors Recent Developments', Noyes Data Corp., New Jersey, 1979.
[3] W. Funke, J. Coat. Technol. 1983, 35, 31.
[4] A. Braig, '68th Annual Meeting and 55th Paint Industries', Show of the FSCT, October 29–31, Washington, 1990.
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Abstract. Radiation curing is an established technology used in many industrial manufacturing processes. New applications and technical specifications stimulate the continuous development of tailor-made photoinitiators which can efficiently meet specific requirements. A new class of radical photoinitiators, bisacylphosphine oxides (BAPO), give four initiating radicals per photoinitiator molecule and undergo photo-oxidative degradation of polymers, are all extremely effective free-radical scavengers [5] and stabilizers for plastics and coatings. Compatibility and long-term retention are obtained by adjustment of $R''$.

Migration of post-added traditional HALS 3 and attachment of functionalized new HALS (e.g. $R, R' = \text{unsaturated groups}$) to the polymer are both subjects of current investigations. In the latter case copolymerization or grafting techniques are applied, e.g. grafting during extrusion ('reactive processing'). Polymer-bound photo-stabilizers outperform traditional products in special new applications such as polymer blends or systems in extractive environments.

4. Conclusion

Polymers and coatings of extended lifetime require light stabilizers of increased performance. New products offer better protection due to their superior efficiency and their ability to remain in the substrate.

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[1] F. Gugumus, in 'Plastics Additives', 3rd edn., Eds. R. Gächter and H. Müller, Hanse Publishers, Munich, 1990, p. 129.
[2] G. Ritz, Mat. Techn. 1989, 77, 40.
[3] J. Rieker, E. Lemmert-Schmitt, G. Goeller, M. Rüssler, G.J. Stueber, H. Schettler, H.E.A. Kramer, J.J. Stezowski, H. Hoier, S. Henkel, A. Schmidt, H. Port, M. Wiechmann, J. Rody, G. Ritz, M. Slongo, J.-L. Birbaum, J. Phys. Chem. 1992, 96, 10225.
[4] H. Brunetti, C.E. Lüthi, Helv. Chim. Acta 1972, 55, 1566.
[5] F. Gugumus, Polym. Deg. Stab. 1993, 40, 167.

1. Introduction

Light-induced polymerization is the basis of important advanced technologies, since it is among the most efficient methods capable to achieve fast and extensive curing of multifunctional oligomers and monomers. Highly reactive systems are cured within a fraction of a second upon exposure to intense UV radiation or laser beams, transforming the liquid resin into a strongly cross-linked solid polymer without the need of additional heat [1].

These features translate into technical advantages which made radiation curable coatings one of the most rapidly develop-