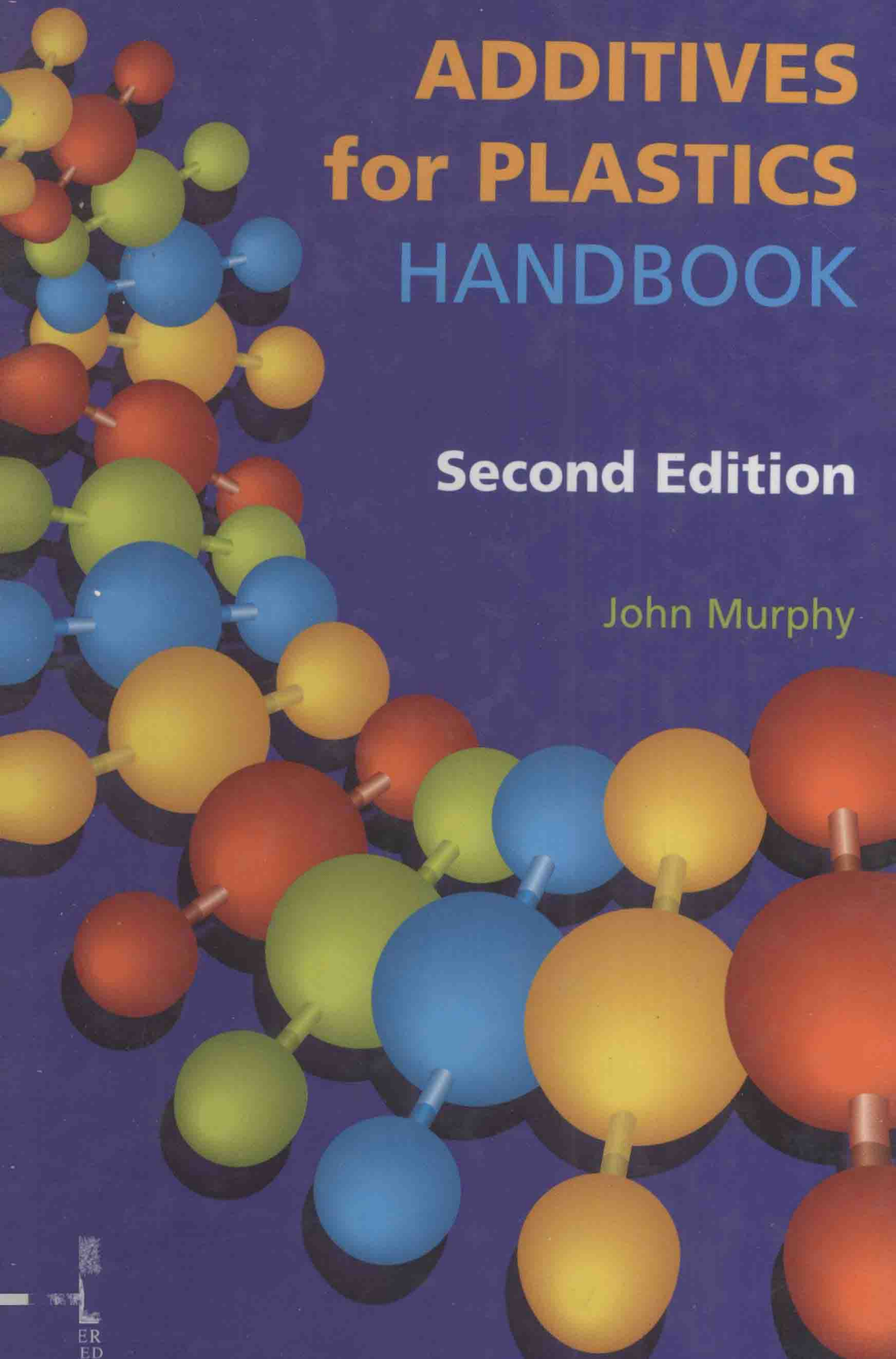
ADDITIVES for PLASTICS HANDBOOK

Second Edition

John Murphy



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Preface

Both technically and economically, additives form a large and increasingly significant part of the polymer industry, both plastics and elastomers. In the five years since the first edition of this handbook, there have been wide-ranging developments, covering the chemistry and formulation of new and more efficient additive systems and the safer use of additives, both by processors in the factory and, in the wider field, as they affect the general public.

It has also become clear that, to meet today's requirements, the budgets for research and development and the structure needed to maintain a global presence are beyond the resources of individual companies, resulting in many mergers and takeovers, leading to the creation of a few world-scale giant producers, complemented by a number of specialists.

This second edition follows the successful formula of the first, presenting a comprehensive view of all types of additives, concentrating mainly on their technical aspects (chemistry/formulation, structure, function, main applications) with notes on the commercial background of each. Whereas reports concentrate on only one sector (such as pigments or 'performance' additives), in this handbook we have again expanded the field to include any substance that is added to a polymer to improve its use, so including reinforcing materials (such as glass fibre), and carbon black and titanium dioxide.

As with the first edition, this information is again presented in a more 'user-friendly' form, starting from the information requirement of the user, and so classifying additives by the properties that they offer and the applications in which they are used. To avoid excessive cross-referencing, there may be some repetition, but it is hoped that the advantages of this form of presentation will outweigh any disadvantage.

JSM, June 2001

Publishers' note

Sadly, just before completion of this book the author, John Murphy, passed away. Elsevier Advanced Technology has endeavoured to complete this work to John's very high standards. We hope that Additives for Plastics Handbook will live up to John's expectations and prove to be an invaluable aid.

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CHAPTER 1

An Overview of Additives

From the very beginnings of the plastics industry, it has been necessary to add materials to a basic polymer resin in order, at least, to make it processable. It has also been clear that additive materials are necessary to modify a resin, to improve properties that are desirable, and to eliminate or mitigate properties that are undesirable. In developing additive systems, the plastics industry has learnt much from the earlier experience of the rubber industry, but the pace of development responding to market needs has produced research in completely new fields, developing additive systems using new chemistry.

While the plastics industry is a major user of additives, it is not the only one. Additives overall can be classified as follows:

Table 1.1 Types and uses of additives

Type	Main applications
Additives	Products, normally used in small quantities, which enhance the value of materials such as plastics, paints, colour prints, and lubricants, by improving their processability, performance, and appearance during manufacture and in use.
Antimicrobials	Substances that prevent the growth of microbes and give consumer products such as soaps and toothpastes a medicated property.
Coatings	The broad term for paints, inks, and lacquers. While often associated with decoration, coatings also protect surfaces from corrosion and damage.
Colours	Can be soluble dyes for textiles, leather, paper, or insoluble pigments for plastics, coatings, and printing inks.
Fine chemicals	Highly complex functional intermediates or ingredients for 'high-tech' applications; for example, in the pharmaceutical, agrochemical, and electronic industries.
Heat and light stabilizers	Additives that prevent the degradation of plastics and coatings under the effects of heat, oxygen, and light.
Optical brighteners	Chemicals which impart whiteness to textiles, detergents, paper, fibres, and plastics.

Type	Main applications
Photo/repro additives	Additives that, when irradiated with light, promote the hardening of printing inks, coatings, and adhesives, and chemically fix images used in electronic or graphic materials.
Pigments	Colorants that remain undissolved before, during, and after application: they are used to colour plastics, inks, paints, and synthetic fibres.
UV curing	Hardening of coatings and adhesives by means of ultraviolet light.
Water treatments	Help purify water for industrial and domestic applications. They also modify water as an agent for the processing of minerals and oils, and have a variety of properties to process water (for example, flocculants separate water from solid particles).

Source: Ciba Specialty Chemicals

For plastics, the range of additives is very large, involving the improvement of many properties:

Table 1.2 The main effect of additives on the properties of a compound

	Calcium carbonate, calcium silicate, powdered aluminium, or copper	Alumina, flint powder, carborundum, silica, molybdenum disulphide	Chopped glass	Mica, silica, powdered or flaked glass	Metallic fillers or alumina	Colloidal silica, bentonite clay
Physical properties						
Thermal conductivity	++	++	++	++	++	–
Heat deflection temperature	++	++	++	++	++	=
Abrasion resistance	=	++	++	++	–	–
Impact strength	–	–	++	–	++	=
Tensile strength	–	=	++	–	=	=
Flexural strength	–	=	++	–	=	=
Compressive strength	–	=	++	–	=	=
Dielectric constant	++	++	++	++	++	=
Processing						
Exotherm	–	–	–	–	–	–
Thixotropy	=	=	=	=	=	++
Machinability	++	–	–	–	++	++
Cost reduction	–	–	=	–	–	++

Key: – decreases;
++ increases;
= essentially no effect.