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Chromatography for Sustainable Polymeric Materials

Renewable, Degradable and Recyclable

Volume Editors:
Ann-Christine Albertsson · Minna Hakkarainen

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Preface

Polymeric materials, both “inert” and degradable, constantly interact with the surroundings. Because of this interaction changes take place in the polymer matrix and small molecules are released to the environment. Reliable methods for testing biodegradability and environmental interaction of renewable resources and biodegradable polymers are required to answer the remaining questions concerning the environmental impact of these future materials. In the case of degradable polymers multiple factors affect the degradation process and small changes in the chemical structure or product formulation may change the susceptibility to degradation or cause different degradation product patterns, rendering the product less environmentally adaptable. Development of sustainable polymeric materials also demands the development of more migration-resistant polymer additives. Chromatographic techniques especially gas chromatography and liquid chromatography preferentially coupled to mass spectrometric detection are ideal tools for studying these low molecular weight compounds and polymer–environment interactions.

In the first chapter of this volume chromatographic fingerprinting and indicator product concepts are presented as tools for evaluating polymeric materials. These concepts have great potential in evaluation of degradation state and life-time/service-life of polymeric materials, evaluation of anti-oxidant or pro-oxidant systems, degradation mechanism and processing parameters as well as rapid comparison and quality control of materials. The solid-phase microextraction technique has rapidly found applications in numerous fields. The second chapter reviews the extraction of polymer degradation products and additives, monomer-rests, odour compounds, migrants from packaging and medical products as well as extraction of polymer additives from environmental samples and biological fluids by solid-phase microextraction demonstrating the high versatility and potential of this technique also in polymer analysis. In the third chapter the possibilities and limitations in the headspace extraction of volatiles from solid polymer matrixes are discussed. Examples of the use of multiple headspace extraction to remove matrix effects are shown and finally the application of headspace analysis for early degradation detection and quality control of recycled materials is presented. The fourth chapter summarises the literature on chromatographic analysis of degradation products from the most common aliphatic and aliphatic–aromatic polyesters. Especially the effect of macromolecular architecture and copolymer composition on the resulting degradation mechanism and degradation product pattern is discussed. The last two chapters deal with the analysis of polymer additives. The fifth chapter overviews different extraction techniques and aspects of analyzing antioxidants in polymeric materials. The sixth chapter discusses the migration of monomeric and polymeric PVC plasticizers with the focus on migration from medical products and food packaging. Especially the possibilities of improving the migration resistance and plasticizing properties of polymeric PVC plasticizers through the right plasticizer design are presented.

The interest in degradable and/or renewable materials is increasing rapidly. Degradation of these materials is still often studied only by measuring the weight loss or changes in molecular weight, which can be misleading. Especially in the case of bioresorbable materials the knowledge of degradation products is a crucial point for biocompatibility of the materials. As an example we have in chapter four presented results showing the influence of macromolecular design on the formation of acidic degradation products, a possible cause of negative impacts in the body. We have also shown that copolymer composition influences the stability, degradation mechanism and amount of degradation products formed during radiation sterilization. Hopefully these chapters will inspire more extensive use of chromatographic techniques for polymer analysis and result in increased understanding of polymeric materials, which in turn will provide tools for the development of sustainable future materials.

Stockholm, April 2008

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