KNOW-HOW FOR POLYMER CHARACTERISATION AND DEVELOPMENT OF BIODEGRADABLE FORMULATIONS FOR FOOD PACKAGING

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RESUM

The Group of Materials Analysis, University of Alicante has a broad experience, expertise and know-how to develop and carry out the characterization of polymer materials, in particular additives, such as plasticizers, colorants and pigments as well as degradation products. Recent expertise in the development of new environmentally-friendly formulations for packaging has lead to the use of biodegradable polymers as base for high-quality and innovative designs.

The know-how involves the ability to measure a large variety of different chemicals used in polymer formulations. The development of analytical methods for identification and further determination of potentially toxic organic compounds has been one of the main fields of work for the Group. Low toxicity and migration degree are two of the parameters for the selection of analytes of the large amount of them currently used in different polymeric formulations.

Techniques for the reliable determination of many different additives used in polymers have been proposed.

In the field of food packaging, new formulations based on biodegradable polymers, in particular polycaprolactone (PCL) and polylactic acid (PLA), with food compatible additives are under study, The addition of natural antioxidants not harmful for humans to commodities used in food packaging is also under study. Those formulations are being characterized and optimized for their use in contact with food.

The Group of Materials Analysis of the University of Alicante seeks to carry out this kind of analyses and associated training activities.



INTRODUCCIÓ

The use of additives in polymeric materials has been known from the beginning of the development of polymer technologies. Their main effect in the polymer formulation is the modification of one or some of the physical or chemical properties with a general improvement of the polymer characteristics. Among the huge amount of chemicals proposed for use as polymer additives, some of them can be considered potentially toxic to humans or the environment. Some of them are also characterized by their high migration level, which can lead to a significant release of chemicals and general loss of properties. It is therefore necessary the development of reliable and reproducible methods for the analysis of such compounds. Almost all of them are organic, this means that chromatographic methods should be useful for the analysis.

Some of them are considered as potentially toxic chemicals. Some reports recently released by the US Environmental Protection Agency and European Committee for Standarization (CEN) clearly describe the public health threat caused by some of these chemicals when used for particular applications.

Industrial fields particularly involved in these studies are food packaging, toys and medical devices manufacturing.

DESCRIPCIÓ TÈCNICA

EXPERIENCE

The main experience of the research group is as follows:

1. Characterization of polymer materials.

a) Mechanical properties.

b) Thermal behavior and degradation at high temperatures.

c) Chemical properties.

2. Determination of additives in polymer materials.

a) Development of new extraction techniques with reduction of analysis time and use of potentially toxic reagents.

b) Optimization of chromatographic procedures.

The methods developed by the Group include the complete study and characterization of the base polymer and further optimization of the conditions

for analysis. Some of the main methods recently developed include:

- Phthalate plasticizers in PVC with proposal of alternative formulations to limit or even avoid the use of controversial chemicals.

- Azo-colorants in PVC and polyolefin formulations. The method includes reduction to aromatic amines and further determination by gas

chromatography.

- Formaldehyde used as preservative in many polymeric formulations.

Phenol and derivatives used as antioxidants and photo-stabilizers in polyolefins.

- N-nitrosamines formed as degradation products in particular conditions.

- Toluene and benzene derivatives used as solvents in paints.

3. Proposal of environmentally friendly formulations for their use in food packaging.

a) Addition of natural antioxidants, such as tocopherol and carvacrol, to commodities with the reduction of potential toxicity to foodstuff

of packaging materials.

b) Modification of biodegradable polymers based on PLA for their use in packaging with improved properties and lower costs.

In both cases the study is mainly focused on the optimization of processing conditions (extrusion and/or casting for films manufacturing) and complete

characterization of these new formulations. Mechanical and chemical properties are particularly important for the study. Among many analytical techniques, infrared spectroscopy, thermal analysis and chromatographic techniques are used in these studies. Permeability of films and migration in food simulants are currently under study.

RESEARCH INTERESTS

The main research interests of the Materials Analysis Group are the following:

- Characterization of polymer materials.

- Thermal degradation of polymers.

- Biodegradable formulations in food packaging.

- Food analysis.

- Proposal of new and harmless formulations for sensitive applications (clinical, toys,...).

INSTRUMENTATION

The Materials Analysis Group owes or can use many different analytical techniques to get a complete characterization of a broad range of polymer

materials.

- Thermogravimetric analysis TGA/DSC Mettler 851-E

- Calorimeter DSC TA Instruments, Q-100

- Gas chromatograph – mass spectrometer Hewlett-Packard mod. HP-5988A

- Liquid chromatograph Waters, mod. 600

- Ionic chromatograph Methrom, mod. 792 Vis-UV spectrometry

- Infrared spectrometry Bruker, Vector-22

- High resolution mass spectrometry MICROMASS AUTOSPEC – ULTIMA NT

- Oxygen permeability Metrotec PA-300

AVANTATGES I ASPECTES INNOVADORS

In the Materials Analysis Group we have developed a joint research with other European laboratories in order to propose an alternative to phthalates in plasticized PVC applications. Those materials previously indicated showed promising results and we are interested in collaborating with industries to introduce these new environmentally friendly formulations in industrial processing.

The know-how involves the ability to analyze a large amount of different additives in polymers even at low concentration (values in the order of nanograms). The development of specific methodology increases the expertise in preparing properly the samples by means of highly sensitive and specific analytical methods.

Innovative formulations with reduced toxicity and totally biodegradable for food packaging are under development and will be ready for industrial and processing studies in a short time. We are seeking research partners (industrial and/or research centers) to prepare proposals for joint research.

ESTAT ACTUAL

The above-indicated formulations have been tested in our laboratory for the complete characterization and determination of potentially toxic chemicals in many types of polymer formulations. It is advisable that the same or a similar procedure could be applied to several other matrices. All the technicians and management staff have the experience necessary to guarantee the success of the methods applied to any polymer sample.

COL·LABORACIÓ BUSCADA

Three types of cooperation are sought by the Department of Analytical Chemistry of the University of Alicante:

• Accomplishment of the application of the environmentally friendly plasticized PVC to industrial processing.

• Development of tailor-made formulations for food packaging based on biodegradable polymers and natural additives.

• Instruct people interested in performing the tasks involved in those analyses, with training courses designed specifically for each situation.

DRETS DE PROPIETAT INTEL·LECTUAL

The Group of Materials Analysis, University of Alicante owns the know-how to carry out the potentially toxic chemicals extraction and determination as well as proposal of new formulations for food packaging.

PERFIL DEL GRUP D'INVESTIGACIÓ

The research team responsible for this laboratory includes Prof. Alfonso Jiménez and 3 grant holders carrying out their jobs to get the PhD degree. One of their main scientific interests is the development of analytical methods for the determination of additives in polymers, as well as studies of degradation phenomena associated to high temperatures during processing and use, and also of the kinetics of these processes. In this sense, they have published more than 40 papers and their contributions to

international conferences are numerous.

The Group of Materials Analysis is currently working together with some other Spanish, European and international institutions:

- Polytechnical University of Valencia (Spain)
- Department of Materials Engineering. University of Perugia (Italy)
- Department of Materials Engineering. University of Lecce (Italy)
- Department of Chemistry. University of Sassari (Italy)
- Department of Chemistry. University of Coimbra (Portugal)
- Food Engineering Department, Universidad Nacional de Quilmes (Argentina)
- Materials Engineering Department, Universidad Nacional de Mar del Plata (Argentina).

Cooperation with some industries and research centers are one of the main points in the group profile:

- Instituto Tecnológico del Plástico, Aimplas, (Valencia, Spain)
- Condensia Química, S.A. (Barcelona, Spain)
- Hospital “Virgen de los Lirios” (Alcoy, Alicante, Spain)

SECTORS D'APLICACIÓ (3)

Agri-food and Fisheries
Pollution and Environmental Impact
Materials and Nanotechnology