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EVALUATION OF FLEXIBLE PACKAGING STRUCTURES FOR HIGH PRESSURE STERILIZATION

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ABSTRACT

In this study has been analysed the effect of high pressure sterilization (90-115 °C, 5000-8000 atm) and Pasteurization (35-40 °C, 5000-8000 atm) on flexible polymeric structures for food packaging. These are the conditions generally used at industrial level to treat packaged food. Effects on single materials as well as on multilayer structures have been examined in terms of morphological/structural, high pressure PVT, mechanical, calorimetric as well as in terms of mass transport (gases and water vapour sorption and permeation) properties, in order to assess the effect of this technology on the features of flexible packaging structures.

Both non-biodegradable and biodegradable commercial polymer films were analysed as well as non-biodegradable multilayer structures, including structures containing metallized layers or aluminium foil layers. The relevant effects are reported, including

delamination which occurred in multilayer structures containing metallized layers.

Key words: gas permeability, pressure, packaging film.

INTRODUCTION

High Pressure Processing (HPP) is a method of food processing where packaged food is subjected to elevated pressures with or without the addition of heat, to achieve microbial inactivation without compromising consumer-desired qualities (Le-Bail *et al.*, 2006). HPP treatments inactivates most vegetative bacteria, retaining food quality, maintaining natural freshness, and extending microbiological shelf life.

In a typical HPP process, the product is packaged in a flexible container (usually a pouch or plastic bottle) and is loaded into a high pressure chamber filled with a pressure-transmitting (hydraulic) fluid. The hydraulic fluid (normally water) in the chamber is pressurized with a pump, and this pressure is transmitted through the package into the food itself.

Here we report on the results of the first part of the research activity where test were performed on single packaging films. The second part of the research, which is now starting, will be focused on the treatment of packaged food.

MATERIALS AND METHODS

The following commercial packaging films used for the tests, are treated at pressure of 8000 bar and temperature at 35-40°C (pasteurization).

Biodegradable commercial film: PCL, PLA and commercial film LLDPE (Simaplast), PET, Aluminum foil.

The following commercial packaging films used for the tests, are treated at pressure of 8000 bar and temperature at 90-115°C (sterilization).

Monolayer samples: LLDPE, PET.

Multilayer samples (*ici*men_{due}): PET/ [cop LLDPE –Octene], PETmet/ [LLDPE], PET/PA/luminium foil/LLDPE.

Permeability tests were performed in a gas membrane-gas configuration (dry conditions) (Del Nobile *et al.*, 1999). The technique used was based on the detection of the pressure increase at the downstream side of the polymer film pressurized at the upstream side. The permeability was computed from the slope of the linear steady-state part of the curve, representing the permeated gas volume as a function of time. The tests were performed at an upstream pressure of 1 atmophere.

For vapour water permeability measure it is used an automatic instrument of Multiperm Extrasolution for permeability analyzer.

The thermal analysis was made using a DSC Q1000 TA Instruments, while the sorption Analyzer using the Q5000 SA TA Instruments.

RESULTS AND CONCLUSIONS

Thermal analysis of all the investigated samples don't show any difference between treated high pressure films and untreated films.

All the investigated samples and structures, with the exception of multilayer structures including aluminum foil or metallized layers, do not display significant changes of gas permeability (CO_2 and O_2) after HPP, showing only a small increase of permeability was observed as compared to untreated samples (see, for example, figure 1 for the case of LLDPE)

However, multilayer structures containing aluminum foil show a decrease of gas permeability (see figure 2) and an increase of barrier properties after HPP: this effect could be related to the presence of possible microdefects (pin-holes) (Del Nobile *et al.*, 1999; Murray) in the untreated metal layer which can be 'closed' as a consequence of the action of high imposed pressure, determining an effective decrease of permeability. Moreover, the bilayer laminated structure made by metallized PET and LLDPE shows, after HPP Sterilization and Pasteurization a dramatic mechanical damage of the film consisting in a delamination. This effect is possibly

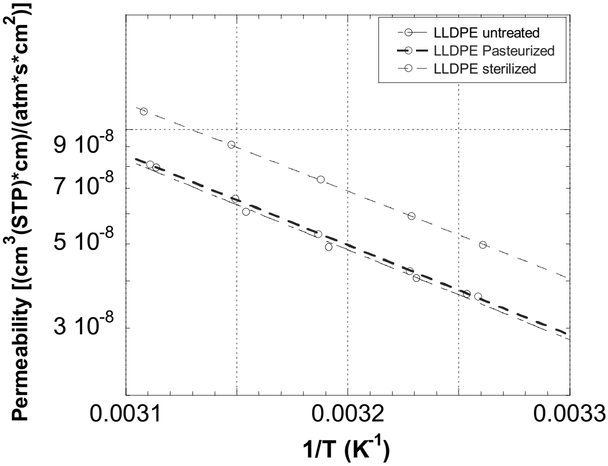

Figure 1

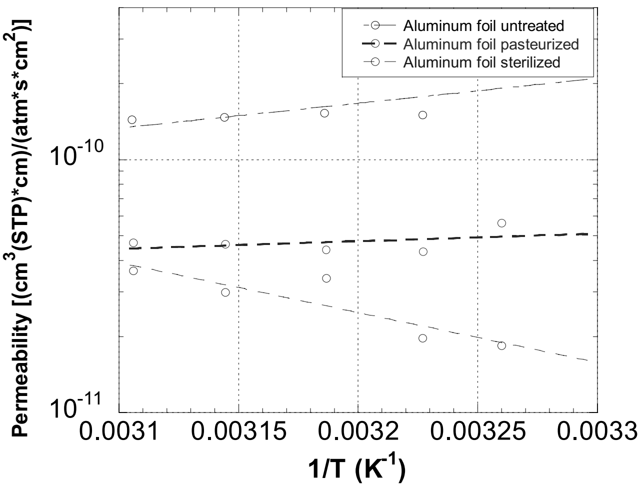

Figure 2

due to the difference in compressibilities of the polymer and metal layers, which, under high pressures, promote the development of interlaminar shear stresses which, in turn, promote the delamination.

Water vapour sorption displayed some differences between treated and untreated samples, with particular reference to LLDPE Simaplast

In conclusion, the result suggest that flexible packaging structures can withstand the conditions imposed by HPP as indicated also by other studies (Caner *et al.*, 2004), with exception of multilayer metallized structures. Tests are in progress to verify this conclusion for the case of packaged food. Moreover, different types of adhesive and optimized metallization procedures are under investigation to make metallized multilayer structures suitable for HPP applications.

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