NEW EXPERIMENTAL TECHNIQUE FOR OBTAINING POROUS POLYMERIC SCAFFOLDS BY USING SUPERCRITICAL CARBON DIOXIDE

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An original experimental equipment was made in order to obtain nanostructurated polymeric systems by processing with supercritical carbon dioxide.

Systems from alginate solutions with several surfactants as additives were used. Two anionic surfactants, sodium dodecylsulfate (SDS) and sodium bis (2-ethyl hexyl) sulfosuccinate (AOT) and a non-ionic surfactant, alkylpolyglucoside (APG) were used for preparing the biopolymeric systems.

The influence of the processing conditions on the morphology of the obtained materials was studied. The properties of the prepared membranes and the pores dimensions were characterised by Scanning Electron Microscopy (SEM). The structure modification and the charge of used surfactants allow the obtaining of different types of materials.

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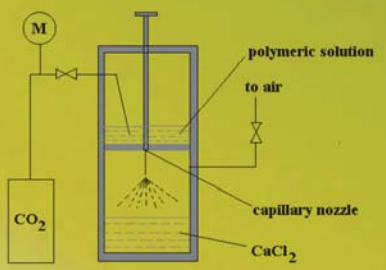
Experimental set-up

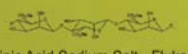


The advantages of the supercritical CO_2 are:

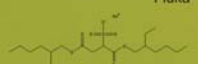
- its mild operation conditions
- gaseous standard state under ambient conditions
- its non-toxicity
- its relatively low cost compared with organic solvents

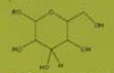
The favorable physical and chemical properties of CO_2 are some of the reasons why so many applications that use sCO_2 focus on pharmaceuticals and biological materials, which are weak in thermal treatment and can not tolerate organic solvent contamination.

Materials:


Alginic Acid Sodium Salt - Fluka


Sodium dodecyl sulphate (SDS) - Fluka


Bis (2-ethyl hexyl) sulfosuccinate (AOT) - Fluka


Alkyl polyglucoside (APG) - Fluka

$CaCl_2$ - Merck; Co_2 99,95% - Linde

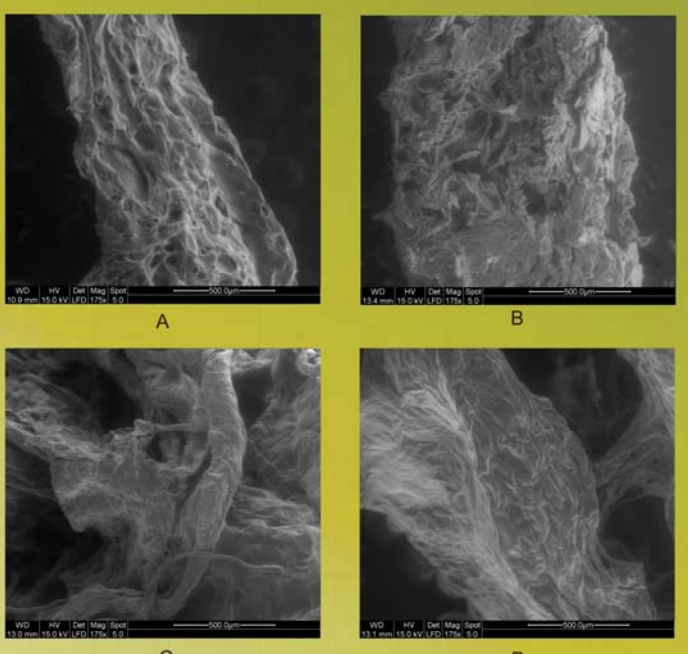
Methodology - Rapid expansion of supercritical solutions (RESS):

In the RESS process, sCO_2 plays a role as a solvent or solute carrier. The active substance is first dissolved into sCO_2 at a given temperature (306,15 K) and pressure (7,5 Mpa) and then the supercritical polymer solution is sprayed into a colection chamber at atmospheric pressure through a nozzle or capillary at a very high velocity. The supercritical fluid solution is expanded adiabatically, which leads to a rapid drop in temperature and pressure and the spontaneous formation of micron-sized liquid droplets or particles, due to a high solute supersaturation.

The major limitation of this process: the low solubility of many materials in sCO_2.

Conclusions:

- A new experimental method and set-up were developed in order to prepare polymeric porous scaffolds that are frequently used in tissue engineering both to transplant cells or growth factors, and to serve as a template for tissue regeneration
- The use of sCO_2 in processing the polymeric gel avoids the presence of volatile organic compound solvents
- The new proposed method is compatible with green and sustainable chemistry
- The final results of processing in sCO_2 depend on physical and chemical properties and surfactant type
- Various morphologies were obtained from gels to nanowires and scaffolds
- Porous scaffolds can be obtained by using AOT and APG surfactants


A B C D

ESEM Images of porous polymeric scaffolds prepared with different surfactants:

A. No surfactant; B. SDS; C. AOT; D. APG

References:

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