BME449 Tissue Engineering

Lecture #11

Scaffolds in Tissue Engineering

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METHOD SELECTION

– Technical procedure

The processing technique should not change the chemical and biophysical properties of the scaffold nor cause any damage to the material structure.

– Fabrication accuracy

The fabrication process should create spatially accurate three-dimensional scaffolds at the macro- and microscale level.

– Automation

The applied technique should be automated in order to ease the production process, reduce the inter-batch inconsistency, ideally reduce the fabrication time and at the same time be cost effective.

MELT (COMPRESSION) MOLDING

PARTICULATE-LEACHING METHOD

PARTICULATE-LEACHING
Properties

- Using the demanded sieve, the sizes of the particulates can be controlled.
- This method provides high porosity up to 97%, and median pore diameters up to 140µm can be prepared.
- The porosity and pore size can be independently controlled by varying the amount and size of the salt particles, respectively.
- The theoretical porosity can be calculated from the weight fraction of salt particulates to polymer and from the densities of polymer and salt.
- the porosity and pore size are not heavily affacted by mixed material.

PARTICULATE-LEACHING

Disadvantages

- Scaffold-impregnated soluble protein cannot be manufactured using this method
- The leaching part of the process can create problems in large-scale manufacturing
- Residual solvent
- The surface of the scaffold may be stopped due to high-pressure solvent.
- Because complete removal of salt from the centre of the scaffold is difficult, this method may not be applied to thicker scaffolds
- Interconnectivity is not too high

ICE PARTICLE-LEACHING

Properties

- The sizes of the ice particulates are controlled by desireable sieve.
- The ice particulates are almost spherical
- Various scaffold forms can be easily manipulated by a designed mould
- The prepared scaffolds are physically stable and manageable
- Highly porous 3D scaffolds with porosities up to 99% and median pore diameters up to 400µm have been prepared using this method
- The proe structures of the 3D scaffolds can be manipulated by controlling the properties of the ice particulates and the polymer concentration

ICE PARTICLE-LEACHING

Disadvantages

- This process must be conducted in a cold condition.
- During the freezing in liquid nitrogen, phase seperation may have occured in the polymer solution, resulting in a deformed porous structure after freeze-drying
- The ice particulates reformed during freezing are influenced by several processing variables such as the temperature of freezing, thus making it difficult to precisely control the pore stucture, including the pore size distribution and the surface area of the scaffold.

GAS FOAMING/SALT-LEACHING

Properties

- Sodium bicarbonate salt or ammonium bicarbonate salt with acidic excipients such as citric acid has been used for effervescent gas-evolving oral tablets, due to its carbon dioxide-evolving property upon contact in acidic aqueous solution. Thus, various alkalising analgesic oral tablets are commercially available.
- In particular, ammonium bicarbonate salt-upon contact in an acidic aqueous solution and/or incubated at elevated temperature-evolves gaseous ammonia and carbon dioxide by itself.
- The gas-foaming/salt-leaching method is based on the idea that sieved salt particles of ammonium bicarbonate dispersed within a polymer-solvent mixture can generate ammonia and carbon dioxide gases within solidifying matrices upon contact with hot water or aqueous acidic solution, thereby producing highly porous structures.
- There is no visible skin layer as in particulte-leaching process
- It is possible to make various scaffolds with different geometries and sizes by a hand-shaping or moulding process.