Materials Science Research India Volume **3**(2a), 283-285 (2006)

Biodegradable polymer for biomedical applications

SUSHANT UPADHYAYA[1], PANKAJ PANDEY[2] and RAJESH VERMA[3]

[1,2]Department of Chemical Engineering,RBS College, Agra (India)
[3]Department of Chemistry,Agra College Agra (India)

(Received: November 08, 2006; Accepted: December 19, 2006)

ABSTRACT

Polymers are applied for a large number of medical applications: as medical supplies, as support or replacement of malfunctioning body parts or as a drug reservoir providing a local therapeutic effect. The specifications for the selected material strongly depend on the application. Various degradable polymer are used in medical field in replacing diseased part, assist in healing, improve function, correct function, correct cosmetic, aid dx, aid tx, replace rotten, replace dead & join replacement, transport through human skin, making artificial corneas by tissue engineering application & hip implant as well as making pacemaker leads etc.The future of Bio medical plastics is an exciting & rapidly growing field, which will incorporate future advancement in biological factors (such as bone growth), directly into an implant's surface to improve Biocompatibility & Bioactivity. Some of Bio medical polymers are *silicone rubber, Dacron, cellulose, PMMA, polyurethane's, hydrogels, X-linkable biodegradable polysters & polyorthoesters etc.*

Key words: Biodegradable polymer, Biomedical applications.

INTRODUCTION

The term "Biodegradable" is often mistaken used to describe all degradable plastics, even though this term actually refers only to material that are consumed by micro-organisms such as bacteria fungi & algae. So the degradable plastics help in the medical application also easily degrade.

During the last 90 years, man made material & devices have been developed to the point of which they can be used successfully to replace parts of living systems in the human body. These special materials- able to function in intimate contact with living tissue, with minimal run or rejection by the body- are called Biomaterials.

Material selection parameters

The parameter for selection of biodegradable polymer which can be used in medical are depend on application *i.e.* terms & conditions, but the major parameters are:

a. Mechanical
b. Water absorption
c. Thermal/electrical conductivity
d. Biostability
e. Diffusion
f. Bio-compatibility
g. Co-monomers and prepolymer

Biocompatibility

The ability of material to perform with an appropriate hot response in a specific application is the Biocompatibility.The response of the host organism (local & synthetic) to the implanted material or device. "Bio compatibility is primarily a surface Phenomenon."

Design concern

Design engineer must consider the physiological loads to be placed on the implants, so they can designed for sufficient structural integrity.

Material choices also must take into account bio compatibility with surrounding tissues, the environment & corrosion tissues, friction & wear of the articulating surfaces & implant fixation either through osseointegration (the degree, to which bone will grow next to or integrate into the implant) bone cement.

Although the wear problem is one of the materials, it plays out as a biological disaster in the body. Any use of the joint, such as walking in the case of knees or hips, results in cyclic articulation of the polymer cup against the metal or ceramic ball. The life of total joint replacement is 8-12 yrs. Even less in more active or younger patients.

Generation Implants

There are basically three generation implants: -

A. First generation implants

It is "**Adhoc**" implants, which is specified by physicians using common & borrowed materials. The successions of this implants were accidental rather than by design.

e.g.
a. Dental implants
b. PMMA dental prosthesis
c. Eyes & other body parts
d. Dacron & parachute cloth vascular implants
e. Intraocular lens: PMMA, acrylic, silicone.

B. IInd. Generation Implants

It is an **Engineered implant** using common & borrowed materials. It is developed through collaboration of physicians of engineers. Basically, it is built on I$^{st.}$ Generation experiences. It is used in material science.

e.g.
a. UHMWPE bearing surface for total joint replacements.
b. Heart valve & Pacemaker made from PU.
c. Orthopedic implants (using polyesters)
d. Opthalmological devices, drug delivery made from hydrogels.

C. IIIrd Generation Implants :

It is **Bioengineered implant** using bioengineered materials. Polymer under development in this implants.

e.g.
a. Tissue engineered implants designed to regrow rather than replace tissue.
b. Artificial skin
c. Resorable bone repair cements using *hydrogel biodegradable polymer*

Some Commonly used biodegradable plastics:

Material	Applications
1. Silicone rubber	Catheters, tubing
2. Dacron	Vascular grafts
3. Cellulose	Dialysis membranes
4. PMMA	Intraocular lenses, bone cement
5. T. Polyurethane	Catheters, Pacemaker leads
6. Hydrogels	Dental implants, filling the bonecavity, assist in healing
7. Polyglycolic acid (Polyester)	Controlled drug releases, bone fixation parts

Uses of Biodegradable polymers

• Replace diseased part	:	Dialysis
• Assist in heating	:	Sutures
• Improve function	:	Contacts
• Correct function	:	Spinal rods
• Aid dx	:	Probe
• Aid tx	:	Catheter
• Replace Dead	:	Skin (Plastic surgery)

Biodegradable Hydrogels

Hydrogels are interesting material for medical application, including drug delivery systems & matrices for cell culture. Biodegradable hydrogels are either based on biopolymers or on poly (ethylene glycol) i.e., (PEG). In the first case the biopolymers, gelatine and/or agarose, was chemically modified in order to introduce polymerizable side groups (methacrylamide, methacrylate) aqueous solution of biopolymers can "Solidify" by physical structuring & then be chemically crosslinked. The ratio physical cross-linkage/chemical cross-linkage can be controlled. Moreover, by means of simply cryogenic treatment phase separations can be achieved when lead to porous materials.

Bio polymers based hydrogels have been evaluated as material for wound treatment. The degradable segment is a depsipeptide consisting of one amino acid & either lactide or glycolide. By varying the depsipeptide composition, the rate of degradation of the hydrogel can be controlled. Such material can be fine tuned for a given application.

Future of Biodegradable polymer in medical

In future, of Bio medical plastic is an exciting & rapidly growing field, which will incorporate further advancement in biological factors (such as bone growth), directly into an implant's surface to improve *Biocompatibility & Bioactivity*.

Advancement in Bio degradable polymer as:

- Cell matrices for 3D growth & tissue reconstruction
- Biosensors, Biomimetic & smart devices.
- Controlled drug delivery/targeted delivery
- Biohybrid organ & cell immunoisolation

(a) New biodegradable polymers
Bioactive, Bio compatibility
(b) New processing techniques.

Inter Disciplinary Field:

- Bioengineers
- Material Scientist
- Immunologists
- Chemists
- Biologist
- Surgeons

What are some of the Challenges???

- To more closely replicate complex tissue architecture & arrangement *in vitro*
- To better understand extra cellular & intra cellular modulates of Cell function.
- To develop novel materials & processing techniques that are compatible with Biological interfaces.
- To find better strategies for Immune acceptance.

Bio Medical Plastics - An Emerging Industry

- Next generation of medical implants & therapeutic modalities.
- Interface of Biotechnology & traditional engineering.
- Significant industrial growth is next 15 years potentially of a multibillion-dollar Industry.

REFERENCES

1. Park, K., Shalaby, w.s.w.,& Park,H., Controlled Release Drug Delivery Systems.,in Biodegradable Hydrogels for Drug Delivery, Technomic Publishing Company,I,Editor. Technomic Publishing Company,Inc., Lancaster. 1-12 (1993).
2. Technical information.physical properties of selected Polymers, Birmingham Polymers.
3. Barton, A.F.M., Solubility Parameters, Chemical Reviews, **75**(6):p.731-753 (1975).
4. Zhang,R.,&Ma,P.X., Application of biomedical Plastics, *Journal of Biomedical Materials Research,* **44**(4): 496-511 (1999).
5. www.rapra.com
6. www.biomat.net
7. www.biomatnet.asp
8. www.etienne.sacact.com