International Journal of Advanced Technology in Engineering and Science
Vol. No.5, Issue No. 03, March 2017
www.ijates.com
ijates
ISSN 2348 - 7550

POLYMERIC NANOPARTICLES AND THEIR APPLICATIONS IN MEDICINE AND INDUSTRY

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ABSTRACT

Polymer nanoparticles have attracted the world due to wide range in multidisciplinary fields such as physics, chemistry, electronics, biology. This review covers the general description of polymeric nanoparticles and its applications in medicine and industry.

Keywords*: *Nanocapsules, Nanoparticles, Nanospheres, Nanotechnology, Polymeric Nanoparticles.

I INTRODUCTION

Nanotechnology is a field of applied science based on the design ,characterization ,production and applications of devices and systems by controlling shape and size at nanometer scale. Nanotechnology is completely diverse and multidisplinary field widely spread in molecular biology, organic chemistry, semiconductor physics, electronic, nanofabrication. Nanotechnology has potential to create new applications innanomedicine, Industry, nanoelectronics, biomaterial energy production and consumer products.

II NANOPARTICLES

Nanoparticles are particles that exist on a nanometer scale i.e. in between 1 to 100 nm at least in one dimension and exhibit size dependent properties.Nanoparticles are classifiedinto ultrafine and fine particles depending on their diameter.Ultrafine particles are nanoparticles of size between 1 to 100 nm and fine particles size between 100 to 2500 nm.

III POLYMERIC NANOPARTICLES

Polymer is a largemolecule or macromolecule consisting of repeated sub units.Polymer nanoparticles (PNPS) are defined as dispersions or solid particles with size in the range 10-1000nm.Drug may be dissolved, entrapped , encapsulated or attached to a nanoparticle matrix.Because these systems have very large surface areas,drugs may be absorbed into their surface and effectively carry drugs, proteins and DNA to target cells.[1]

Depending upon the method of preparation two types of polymeric nanoparticles are formed.

- Nanocapsule
- Nanospheres

Nanocapsule is a nanoscale shell made from a nontoxic polymer.Nanocapsules are the systems in which drug is confined to a cavityconsisting of an inner liquid core surrounded by a unique polymer membrane. Nanospheres are the spherical particles which have size in between 10 to 200 nm in diameter and exhibit size dependent properties .The nanospheres are matrix systems in which drug is physically and uniformly dispersed. They are biodegradable(broken down)and self assembling and have potential as drug carriers and imaging agents[6].

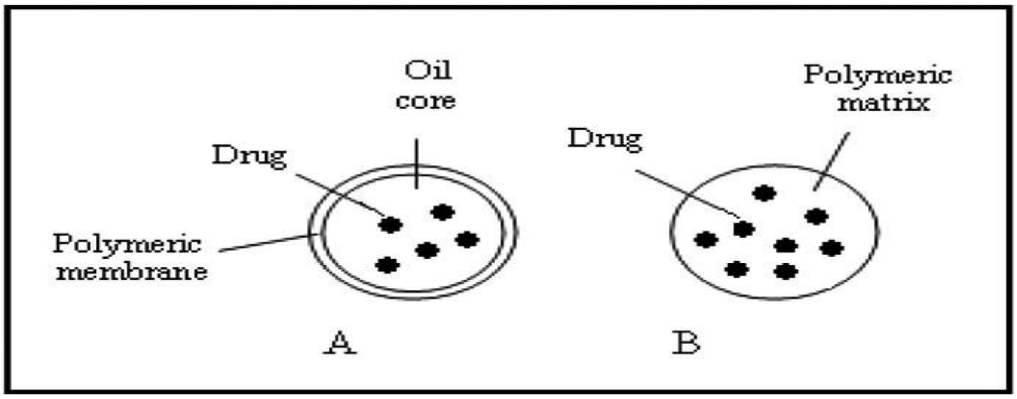

Fig.1:A) nanocapsule B)nanospheres

IV POLYMERS USED IN THE NANOPARTICLE PREPARATION

The polymers should be compatibility with the body in terms of non-toxicity and non-antigenicity and should be biodegradable and biocompatible [1][2]

- Natural hydrophilic polymer
- Synthetic hydrophobic polymer

Different polymers used in nanoparticles

TABLE-1

Type of polymer	Examples
Natural hydrophilic polymer	Gelatin, chitosan, xanthan gum, acacia, albumin, sodiumal ginate
Synthetic hydrophobic polymer	Polylactides, polyvinylchloride, thermoplastic, polyethelene, polyanhydrides, polycaprolactone

V METHODS FOR PREPARATION OF POLYMERIC NANOPARTICLES

- Solvent evaporation
- Nanoprecipitation
- Solvent diffusion
- Salting out
- Ionic gelation

- Dialysis
- Spray drying method
- Double emulsion method[1][3]

VI CHARACTERIZATION OF POLYMERIC NANOPARTICLES

- Purity and quality
- Particle size and size distribution
- Percentage of yield
- Percentage of efficiency
- Drug release parameters
- Hydrophilicity and surface charge density[4]
- Stability

VII ADVANTAGES OF POLYMERIC NANOPARTICLES

- Delivers high concentration of pharmaceutical agent to desired location.[1]
- Controlled and sustained release of the drug during transportation and at the site of location.
- Decreased toxicity and occurrence of adverse drug reactions.
- Better drug utilization.
- Polymeric nanoparticles can be easily incorporated into other activities such as drug delivery.
- They can be easily and cheaply fabricated by multimethods in large quantities.
- Both active and passive drug targeting can be achieved by manipulating the particle size and surface characteristics of nanoparticles.[4]

VII DISADVANTAGES OF POLYMERIC NANOPARTICLES

- Requires skill to manufacture
- Highly sophisticated technology
- Reduced ability to adjust the dose
- Productivity is difficult
- Industrial applications,technical transfer to commercial production is very difficult
- Yield is more but very costly formulation
- Physical handling ofnanospheres is difficult.[4][5]

VIII APPLICATIONS OF POLYMERIC NANOPARTICLES

8.1 Medicine

- Drug delivery involves polymeric nanoparticles to deliver drugs,heat,light or other substances to cancer cells. These particles are directly attracted to cancer cells and reduces damage to healthy cells. Targeted drug delivery system (TDDS) is applied to treat cancer. Polymeric nanoparticles are used as the carrier of anticancer agents in TDDS.Polymeric micelle nanoparticles and Gelatin nanoparticles are used to deliver drugs to tumors and brain damaged tissue respectively. [5]

- Therapy techniques involvenanospongesof polymeric nanoparticles coated with redblood cell membrane to absorb toxins.Bismuth nanoparticles are used in radiation therapy to treat cancer tumors.[6]
- In diagnostic techniques antibodies attached to carbon nanotubes in chips are used to detect cancer cells.
- In anti-microbial techniques polymer coated iron oxide nanoparticles to treat chronic bacterial infections. Nanocapsules containing antibiotics are coated on burndressing .
- In surgery minute surgical instruments can be made used to perform microsurgeries on any part of the body. The affected area is targeted instead of damaging a large amount of body.Surgery can also be done on tissue,genetic and cellular levels.
- In medical robotics nano robots are programmed to repair specific diseased cells which functions as antibodies as in healing process. Applications include early diagnosis,targeted drug delivery for cancer,surgery,biomedical instruments,monitoring of diabetes.[5]-[6]

8.2 Industry

- In food industry high quality and safe food is manufactured by using polymer nanotechnology food packing (PNFP).Improved, active and intelligent food packing, nanoencapsulation of bioactive food compounds are few applications in industry.In improved-PNFP a homogenous dispersion of clay particles in polymeric matrix improves the packing properties such as flexibility, gas barrier properties, temperature and moisture stability. In active –PNFP the presence of gold, silvernanoparticles in polymeric matrix allow packages to interact with environment and food to preserve them fresh and safe. In intelligent the presence of nanosenors in polymeric matrix can detect chemical compounds, pathogens, toxins in food ,expiration dates, freshness food. Bacteria identification and quality monitoring is done by biosensors. [7][11]
- In electronic industry CdS polymer nanoparticles are used to prepare solar cells of high panel flexibility and cheaper. Polymer based organic thin film transistors (OTFT) offer high mobility. Polymer semiconductor nanocomposites are used to prepare optical displays,photoconductors ,superconductor devices,gas sensors. Polymer nanoparticles are used in batteries,chemical sensors,memory devices and windows.Conjugated polymers with various nanoscale filler are used in sensor applications. [2][8]
- The smart coated polymer have applications in fabrication of transparent substrate, nonstick, self healing and self cleaning in antistain and stratch-resistant coatings to reform original position of apparatus under stress.Antireflective polymer coatings are used to produce safe mirrors in aumobile industry.
- In textile industry nanofibers makes clothes water and stain repellent.Inorganic UV blockers are more preferable to organic UV blockers as they are non-toxic and chemically stable under exposure to both high temperatures and UV.[9]
- In cosmetic industry polymeric nanoparticles are used in drug delivery are useful in makeups,perfumes,sunscreen lotions,creams.This encapsulated polymer nanoparticles penetrate into the top layer of the skin due to small size of the particles.[10]
- In military coated polymer threads woven into the soldiers uniform is used for communication purposes. Biological sensors are used to detect biological agents.

IX CONCLUSION

This is the concise review of polymeric nanoparticles and their applications in medicine and industryBy this study we can conclude that polymeric nanoparticles have great potential to convert poor soluble and poor absorbed drugs into better drugs.It includes analysis of recent development in technology.

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