www.ThePharmaJournal.com

The Pharma Innovation

ISSN (E): 2277- 7695
ISSN (P): 2349-8242
NAAS Rating: 5.23
TPI 2021; SP-10(5): 660-663
© 2021 TPI
www.thepharmajournal.com
Received: 07-03-2021
Accepted: 09-04-2021

Sonu Rani
Ph.D. Scholar, Department of Clothing and Textiles, GBPUA and T, Pantnagar, Uttarakhand, India

Alka Goel
Professor and Dean, College of Home Science, GBPUA and T, Pantnagar, Uttarakhand, India

Corresponding Author:
Sonu Rani
Ph.D. Scholar, Department of Clothing and Textiles, GBPUA and T, Pantnagar, Uttarakhand, India

Microencapsulation technology in textiles: A review study

Sonu Rani and Alka Goel

Abstract
"Small is better" motto is true to microencapsulation process. Small microcapsule do fascinating job. Microencapsulation technology allows liquids, solids, or gases to be encapsulated inside a tiny sphere known as microcapsule. Microcapsule is a tiny sphere with uniform wall around it. The particle component is called as the "core material", and polymers are known as wall material, shell, coating, carrier, or encapsulant. Microencapsulation is done to protect the core material from light, moisture, temperature, and oxygen, to extend shelf-life and to enhance release properties of compounds. Microcapsules can be categories into microcapsules or nanaocapsules, monocored microcapsules, polycored microcapsules and matrix type microcapsules. Microcapsules can be prepared by using spray drying, pan coating, centrifugal extrusion, solvent evaporation, simple coacervation, complex coacervaton, *In situ* polymaerzation of, in interfacial polymerization. Microcapsules can be used in phrase change materials, fragrance finishes, fire retardant materials and antimicrobial finishes. Need arises for optimization of the methods for formation of microcapsules and extend the shelf life of treated materials to achieve large scale industrial production.

Keywords: microencapsulation, core material, shell material, simple coacervation, complex coacervation

1. Introduction
Microencapsulation is a process in which small capsules of many useful properties are made by using tiny particles or droplets surrounded by a coating [17]. "Small is better" motto is true to microencapsulation process. The microencapsulation process is used to entrap small particle soft liquids, solids, or gases in one or two polymers. The particle component is referred as the core material and polymers are called variously such as wall material, shell, coating, carrier, or encapsulant [13]. Microencapsulation means packaging an active ingredient inside a capsule ranging in size from one micron to several millimeters [1, 2]. The purpose of microencapsulation is to protect the core material from environmental factors such as light, moisture, temperature, and oxygen, to extend shelf-life and to improve the release properties of compounds. Many factors affect the quality of microcapsules, including preparation techniques, types of core material, and types of wall material. This technique is now widely used in textile finishing also. Many special and functional properties can be imparted to the fabrics by microencapsulating the core material. This core material can be any substance having a special function to perform for the fabric. Encapsulation has allows moisturizers, therapeutic oils, and insecticides to be incorporated into fabrics.
Microencapsulation technology has been used in sportswear and medical textiles for protection against microbial agents. The technology was also proved useful for manufacturing of various kinds of textile finishes and preparation of chemicals that are used in agriculture, pesticides and herbicides, cosmetics, flavours and essence, food additives, for probiotics and pharmaceuticals, for specific drug delivery etc.

2. Structure of microcapsule
The realization of the potential that microencapsulation offers involves a basic understanding of the general properties of microcapsules, such as the nature of the core and coating materials, the stability and release characteristics of the coated materials and the microencapsulation methods.

A. Core material
The core material, defined as the specific material to be coated, can be liquid or solid in nature. The composition of the core material can be varied as the liquid core can include dispersed

and/or dissolved material. The solid core can be mixture of active constituents, stabilizers, diluents, excipients and release-rate retardants or accelerators. The ability to vary the core materials composition provides definite flexibility and utilization of this characteristic often allows effectual design and development of the desired microcapsules properties [1].

B. Coating material
The selection of appropriate coating material decides the physical and chemical properties of the resultant microcapsules/microspheres.

3. Classification
Microcapsules can be classified on the basis of their size or morphology.

A. Micro/Nanocapsules
Microcapsules range in size from one micron (one thousandth of a mm) to few mm. Microcapsules whose diameter is in the nanometer range are referred to as nanocapsules to emphasize their smaller size [3].

B. Morphology microcapsules
Microcapsules can be classified into three basic categories as given below:

a. Monocored microcapsules- have a single hollow chamber within the capsule.
b. Polycore microcapsules- have a number of different sized chambers within the shell.
c. Matrix type microparticle- has the active ingredients integrated within the matrix of the shell material. However, the morphology of the internal structure of a microparticle depends largely on the selected shell materials and the microencapsulation methods that are employed.

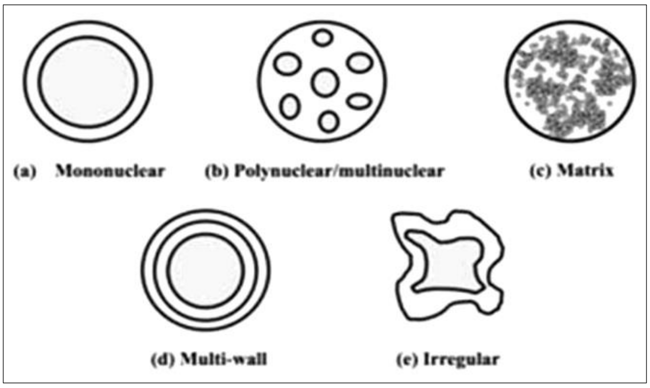

Fig 1: Morphology of microcapsules [13]

One of the most significant features of microcapsules is that it allows for a huge surface area. The total surface area of 1mm of hollow microcapsules whose diameter of 0.1 mm to be about 60 m^2. The total surface area is inversely proportional to the diameter. This large surface area is available for sites of adsorption and desorption, chemical reactions, light scattering, etc.

4. Reasons for microencapsulation
Microencapsulation of materials is to ensure that the encapsulated material reaches the area of action without getting adversely affected by the environment. The principal reasons for encapsulation are:

a. Masking of odour, taste and activity of encapsulated materials
b. Separation of incompatible components
c. Controlled release i.e. sustained or delayed release of active compounds
d. Conversion of liquids to free flowing solids
e. Protection of the immediate environment
f. Stability of encapsulated materials increased
g. Targeted release of encapsulated materials

5. Methods of formation of microcapsules
Microcapsules can be prepared with following methods as given below [12]:

A. Mechanical methods
The microcapsule wall is mechanically applied or condensed around the microcapsulecore e.g. spray drying, pan coating, extrusion, deposition in vacuum, solvent evaporation.

a. Spray drying: The core material is dissolved in the polymer in the form of solution or in melt form and it is sprayed and dried, there by shell material solidifies and thus the formation of microcapsule
b. Pan Coating: The core particle is poured in the pan and polymer is slowly added inside the pan which rotating at slower speed to ensure proper coating on the surface of the core material.
c. Air Suspension coating: It involves the dispersion of the core material in a supporting air stream and the spray coating on the air suspended particles [10].
d. Centrifugal extrusion: In this system concentric feed system is used and contains the head of nozzle for both core and shell part. The active core in liquid form is placed in the center part of the nozzle and the polymer in melt or solution form is placed in the shell part of the nozzle and when it emerges at exit, vibration take place, followed by curing action there by formation of microcapsule
e. Solvent evaporation method: The polymer material is dissolved in the volatile solution and the active core material is slowly dissolved in this dissolved polymer volatile solution. The solution is heated to evaporate the solvent leaving the microcapsule.

B. Coacervation
The macromolecular colloid rich coacervate droplets surround dispersed microcapsule cores and form a viscous microcapsule wall, which is solidifed with cross-linking agents. This phenomenon taking place in colloid systems.

i) Simple coacervation: In case of simple coacervation a disolvation agent is added for phase separation [8].

ii) Complex coacervation: Complex coacervation refers to the phase separation of a liquid precipitate or phase when solutions of two hydrophilic colloids are mixed under suitable conditions. This forms the three phases of the solution and then solvent evaporates and left behind is the sheath over core material [8].

C. Polymerisation
The monomers polymerise around the droplets of an emulsion and form a solid polymeric wall.

i) *In situ* polymerization

Monomers or pre condensates are added only to the aqueous phase of emulsion.

ii) In interfacial polymerization

One of the monomers is dissolved in the aqueous phase and the other in a lypophilic solvent [12].

6. Use of microcapsules in textiles field

a. **Phase-change materials:** Phase-change materials perform the function of changing the aggregation from solid to liquid within certain range of temperature. Microcapsules of phase-change materials reduce the effect of extreme variations in temperatures. This facilitates the thermoregulation of clothing and the constant temperature is provided. These kinds of microcapsules are applied to different materials, vests, parkas, snowsuits, blankets, mattresses etc.
b. **Fragrance finishes:** Fragrance finishes have been directly applied on to fibers and fabrics numerous times, but the aroma does not last for more than two wash cycles. Microencapsulation of fragrances is a technique which when used on the fabric gives a longer effect. This technique is commonly used in aromatherapy in which microcapsules may contain essential oil flavours like lavender, rosemary, pine etc. This is basically done to treat insomnia, headache, and to prevent bad odour.
c. **Fire retardants:** Microcapsules with fire retardant core were developed to overcome the problem of reduced softness which is caused by the direct application of fire retardant materials. They are applied to fabrics used in military applications like tentage [15].
d. **Polychromic and thermo-chromic microcapsules:** The colour changing systems changes colour in response to temperature, which is termed as thermo-chromatic and the other changes colour in response to UV light, this is known as photo-chromatic. In textiles, polychromic and thermo-chromic microcapsules can be found in product labelling, medical and security applications. There are microencapsulated thermo-chromatic dyes that change colour at specific temperature - in response of human contact [15].
e. **Antimicrobials:** Bacteria often cause microbiological decay of fabrics which in turn causes loss of various useful properties of fabrics. This problem can be prevented by the use of anti-microbial finishes that can be applied with the help of microencapsulation. This finish is especially for textiles for medical and technical use.
f. **Counterfeiting:** Imitation of high added value textiles, branded and designer goods can be dealt with by the use of microencapsulation. Microcapsules applied to label contain a colour former or an activator. light or a solvent, microcapsules break open, the content is released, colour is developed and in this way detection is achieved [17].

7. Conclusion

Microencapsulation as research axis has excellent potential for development, especially in the formulation of more environmentally friendly methods, the choice of the active ingredients to be coated or the formulation of a polymer shell. To impart desirable qualities to textile materials microencapsulation was found to be the most effective method due to which we can actively moisturize our clothing, heal and even can release fragrances to reduce anxiety. Due to growing health concerns among users, new materials are being explored and use of organic compounds both in sheath and core. Microencapsulation technology has a promising future, however, one aspect that seems critical is the intended delivery of the encapsulated core on particular external stimulus. Need arises for optimization of the methods of producing microcapsules and extend the shelf life of treated materials to achieve large scale industrial production for each specific application.

8. References

1. Bansode *et al.* Microencapsulation: A review. International Journal of Pharmaceutical Sciences Review and Research 2010;1(2):43.
2. Chanana Arsh, Kataria MK, Sharma M, Bilandi A. Microencapsulation: Advantages in applications. International Research Journal of Pharmacy 2013;4(2):1-5.
3. Dubey R, Shami TC, Rao KUB. Microencapsulation technology and applications. Defence Science Journal 2009;59(1):82-95.
4. Ducel *et al*. Evidence and characterization of complex coacervates containing plant proteins: application to the microencapsulation of oil droplets. Colloids and surfaces: A physiological engineering aspects 2004;232:239-247.
5. Fabien Salaün. Microencapsulation as an Effective Tool for the Design of Functional Textiles. Advances in Textile Engineering 2020. Retrieved from https://openaccessebooks.com/advances-in-textile-engineering/microencapsulation-as-an-effective-tool-for-the-design-of-functional-textiles.pdf on 30.12.2020
6. Jaipura J, Kumari P, Rani N. Microencapsulation applications in development of functional textiles. Asian Textile Journal 2016, 45-49.
7. Jaipura L, Saini M, Rangi A. Development of herbal mosquito repellent textiles using essential oils of pine, guggul and rosewood. Colourage 2016, 44-48.
8. Jyothi Sri S *et al*. Microencapsulation: A review. International Journal of Pharma and Bio Sciences 2012;3(1):509-531.
9. Yip J, Luk MYA. Microencapsulation technologies for antimicrobial textiles. Journal of Antimicrobial Textiles 2016.
10. Kaur L, Sharma S, Guleri TK. Microencapsulation: A new era in Novel Drug Delivery 2013;2(2):456-468.
11. Lee SW, Kim MH, Kim CF. Encapsulation of ethanol by spray-drying technique: effects of sodium-lauryl sulfate. International Journal of Pharmaceutics 1999;187:193-198.
12. Marica Starerinic, Bostjan Sumiga, Bojana Boh Podgornik. Microencapsulation for textile applications and use of SEM image analysis for visualization of microcapsules 2011. Retrieved from https://www.researchgate.net publication/287447957
13. Methavee Peanparkedee, Santoshi Iwamoto, Ryo Yamauchi. Microencapsulation: A review of application in the food and pharmaceutical industries 2016. Retrieved from https://www.researcggate.net/publivcation /31/8235:56-65
14. Miro Specos MM *et al*. 2010. Microencapsulated citronella oil for mosquito repellent finishing of cotton textiles. Transactions of the Royal Society of Tropical Medicine and Hygiene 2010;104:653–658.

15. Nelson. Use of UV Microencapsulation For Textile Finishing 2002. Retrived for DOI: 10.9790/019X-0220104 www.iosrjournals.org 3 | Page
16. Sri SJ *et al*. Microencapsulation: a review. International Journal of Pharma and Bio Sciences 2012;3(1):509-531.
17. Shrimali K, Dedhia EM. Microencapsulation for Textile Finishing. IOSR Journal of Polymer and Textile Engineering 2020;2(2):01-04.
18. Hammad U *et al*. Microencapsulation: Process, techniques and applications. International Journal of Research in Pharmaceutical and Biomedical Sciences 2011;2(2):474-481.
19. Venkatesan P, Manavalan R, Valliappan K. Microencapsulation: a vital technique in novel drug delivery system. Journal of Pharmaceutical Sciences and Research 2009;1(4):26.
20. Zhang *et al*. Recent advances in cotton genomics. International journal of Plant genomics 2018. Retrieved from http:www.ncbi.nim.nih.gov/pmc/article/PMC2233810 on 13 Jan 2018
21. Zubair M *et al*. 2013. Retrieved from http:dx.doi.org/10.1155/2013/489071
22. Wikipedia 2017. Retrieved from https://enwikipedia.org/wiki/microencapsulation on 3 April 2017.
23. Sumithra M. Effect of insect repellent property using microencapsulation technique. World Journal of Pharmaceutical Research 2016;5(4):715-719.