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# A Review on Microencapsulation Techniques

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## ABSTRACT

The review of Microencapsulation is a well-established dedicated to the preparation, properties and uses of individually encapsulated novel small particles, as well as significant improvements to tried-and-tested techniques relevant to micro and nano particles and their use in a wide variety of industrial, engineering, pharmaceutical, biotechnology and research applications. Its scope extends beyond conventional microcapsules to all other small particulate systems such as self-assembling structures that involve preparative manipulation. The review covers reasons for microencapsulation,encapsulation materials,core material and techniques of preparation.

**Keywords:** Microencapsulation, Core Materials, Coating Materials

## Introduction

Microencapsulation, as a process, is application of relatively thin coatings to small particles of solids or droplets of liquids and dispersions. It is a process of surrounding, capsulating or enclosing a substance inside a small capsule. Extremely tiny droplets or particles of liquid, dispersion or solid material, are packed within a second material or coating polymer film for shielding the active material from surrounding environment. The size of microcapsule ranges from one micron to seven millimeter. Microencapsulation provides the means of converting liquids to solids, altering colloidal surface properties, providing environmental protection and controlling the release characteristics or availability of coated materials. Several of these properties can be attained by macro-packaging techniques, however, the uniqueness of microencapsulation is the smallness of the coated particles and there subsequent use and adaptation to a wide variety of dosage forms and product application. The materials to be coated are referred to as core, internal phase, active ingredient, fill, payload or nucleus, whereas the coatings of microcapsules are termed as wall, shell, external phase, membrane or coating. Microcapsules may have one or multiple coatings arranged in strata of varying thicknesses around core material. All the three states of material i.e. solid, liquid and gas, may be encapsulated and affect shape and size of resultant capsules.[1]

Microencapsulation also includes bio-encapsulation which is more restricted to the entrapment of a biologically active substance (DNA, entire cell or group of cells) generally to improve its performance and to enhance its shelf life. Because of the smallness of the particles, drug moieties can be widely distributed throughout the GIT, thus potentially improving drug sorption.

## Reasons for Microencapsulation

- The primary reason for microencapsulation is found to be either for sustained or prolonged drug release.
- This technique has been widely used for masking taste and odor of many drugs to improve patient compliance.

- This technique can be used for converting liquid drugs in a free flowing powder.
- The drugs, which are sensitive to oxygen, moisture or light, can be stabilized by microencapsulation.
- Incompatibility among the drugs can be prevented by microencapsulation.
- Vaporization of many volatile drugs e.g. methyl salicylate and peppermint oil can be prevented by microencapsulation.
- Many drugs have been microencapsulated to reduce toxicity and GI irritation including ferrous sulphate and KCl.
- Alteration in site of absorption can also be achieved by microencapsulation.
- Toxic chemicals such as insecticides may be microencapsulated to reduce the possibility of sensitization of factorial person.
- Bakan and Anderson reported that microencapsulated vitamin a palmitate had enhanced stability. [2]

**Core Material**

The "core material" is 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 or dissolved material and the solid core can be a mixture of active constituents, stabilizers, diluents, excipients and release rate retardants or accelerators. The ability to vary the core material composition provides definite flexibility and utilization of these characteristics often allows effectual design and development of the desired microcapsule properties.

**Coating material**

The selection of the appropriate coating material is responsible for the resultant physical and chemical properties of the microcapsules. The coating materials should be capable of forming film that is cohesive with the core material, be chemically compatible and non-reactive with the core material provide the desired coating properties such as strength, flexibility, impermeability, optical properties and stability.[3]

**Techniques to Manufacture Microcapsules**

**Physical methods**

**Air-suspension coating**

Air-suspension coating of particles by solutions or melts gives better control and flexibility. The particles are coated while suspended in an upward-moving air stream. They are supported by a perforated plate having different patterns of holes inside and outside a cylindrical insert. Just sufficient air is permitted to rise through the outer annular space to fluidize the settling particles. Most of the rising air (usually heated) flows inside the cylinder, causing the particles to rise rapidly. At the top, as the air stream diverges and slows, they settle back onto the outer bed and move downward to repeat the cycle. The particles pass through the inner cylinder many times in a few minutes methods.

The air suspension process offers a wide variety of coating materials candidates for microencapsulation. The process has the capability of applying coatings in the form of solvent solutions, aqueous solution, emulsions, dispersions or hot melts in equipment ranging in capacities from one pound to 990 pounds. Core materials comprised of micron or submicron particles can be effectively encapsulated by air suspension techniques, but agglomeration of the particles to some larger size is normally achieved. [4]

**Coacervation Process**

The core material will be added to the solution. The core material should not react or dissolve in water (maximum solubility 2%). The core material is dispersed in the solution. The particle size will be defined by dispersion parameter, as stirring speed, stirrer shape, surface tension and viscosity. Size range 2µm - 1200µm. Coacervation starts with a change of the pH value of the dispersion, e.g. by adding $H_2SO_4$, HCl or organic acids. The result is a reduction of the solubility of the dispersed phases (shell material).

- The shell material (coacervate) starts to precipitate from the solution.
- The shell material forms a continuous coating around the core droplets.
- The shell material is cooled down to harden and forms the final capsule.

**Coacervation-Phase Separation**

The general outline of the processes consists of three steps carried out under continuous agitation: A liquid manufacturing vehicle phase, a core material phase, and a coating material phase. To form the three phases, the core material dispersed in a solution of the coating polymer, the solvent for the polymer being the liquid manufacturing vehicle phase. Deposition if the liquid polymer coating around the core material occurs if the polymer is adsorbed at the interface formed between the core material and the liquid vehicle phase, and this adsorption phenomenon is a prerequisite to effective coatings, rigidizing the coating, usually by thermal, cross- linking, or desolvation techniques, to form a self- sustaining microcapsules. [5,6]

**Centrifugal extrusion**

Liquids are encapsulated using a rotating extrusion head containing concentric nozzles. In this process, a jet of core liquid is surrounded by a sheath of wall solution or melt. As the jet moves through the air it breaks, owing to Rayleigh instability, into droplets of core, each coated with the wall solution. While the droplets are in flight, a molten wall may be hardened or a solvent may be evaporated from the wall solution. Since most of the droplets are within ± 10% of the mean diameter, they land in a narrow ring around the spray nozzle. Hence, if needed, the capsules can be hardened after formation by catching them in a ring-shaped hardening bath. [7]

**Pan coating**

The pan coating process, widely used in the pharmaceutical industry, is among the oldest industrial procedures for forming small, coated particles or tablets. The particles are tumbled in a pan or other device while the coating material is applied slowly. The pan coating process, widely used in the pharmaceutical industry, is among the oldest industrial procedures for forming small, coated particles or tablets. The particles are tumbled in a pan or other device while the coating material is applied slowly with respect to microencapsulation, solid particles greater than 600 microns in size are generally considered essential for effective coating, and the process has been extensively employed for the preparation of controlled - release beads. [8]

**Spray drying**

Spray drying serves as a microencapsulation technique when an active material is dissolved or suspended in a melt or polymer solution and becomes trapped in the dried particle. The main advantages is the ability to handle labile materials because of the short contact time in the dryer, in addition, the operation is economical. In modern spray dryers the viscosity of the solutions to be sprayed can be as high as 300 mPas.

Spray drying and spray congealing processes are similar in that both involve dispersing the core material in a liquefied coating substance and spraying or introducing the core-coating mixture into some environmental condition, whereby, relatively rapid solidification (and formation) of the coating is affected. The principal difference between the two methods is the means by which coating solidification is accomplished. Coating solidification in the case of spray drying is effected by rapid evaporation of a solvent in which the coating material is dissolved. Coating solidification in spray congealing methods, however, is accomplished by thermally congealing a molten coating material or by solidifying a dissolved coating by introducing the coating - core material mixture into a nonsolvent. Removal of the nonsolvent or solvent from the coated product is then accomplished by sorption, extraction, or evaporation techniques. [9, 10, 11]

**Chemical process**

**Solvent Evaporation**

This technique has been used by companies including the NCR Company, Gavaert Photo Production NV, and Fuji Photo Film Co., Ltd. to produce microcapsules. The processes are carried out in a liquid manufacturing vehicle. The microcapsule coating is dissolved in a volatile solvent, which is immiscible with the liquid manufacturing vehicle phase. A core

material to be microencapsulated is dissolved or dispersed in the coating polymer solution. With agitation, the core coating material mixture is dispersed in the liquid manufacturing vehicle phase to obtain the appropriate size microcapsule. The mixture is then heated (if necessary) to evaporate the solvent for the polymer. In the case in which the core material is dispersed in the polymer solution, polymer shrinks around the core. In the case in which core material is dissolved in the coating polymer solution, a matrix - type microcapsule is formed. Once all the solvent for the polymer is evaporated, the liquid vehicle temperature is reduced to ambient temperature (if required) with continued agitation. At this stage, the microcapsules can be used in suspension form, coated on to substrates or isolated as powders. The solvent evaporation technique to produce microcapsules is applicable to a wide variety of liquid and solid core materials. The core materials may be either water - soluble or water - insoluble materials. A variety of film - forming polymers can be used as coatings. [12]

**Polymerization**

**Interfacial polymer**

In Interfacial polymerization, the two reactants in a polycondensation meet at an interface and react rapidly. The basis of this method is the classical Schotten Baumann reaction between an acid chloride and a compound containing an active hydrogen atom, such as an amine or alcohol, polyesters, polyurea, polyurethane. Under the right conditions, thin flexible walls form rapidly at the interface. A solution of the pesticide and a diacid chloride are emulsified in water and an aqueous solution containing an amine and a polyfunctional isocyanate is added. Base is present to neutralize the acid formed during the reaction. Condensed polymer walls form instantaneously at the interface of the emulsion droplets.

**In-situ polymerization**

In a few microencapsulation processes, the direct polymerization of a single monomer is carried out on the particle surface. In one process, e.g. Cellulose fibers are encapsulated in polyethylene while immersed in dry toluene. Usual deposition rates are about 0.5µm/min. Coating thickness ranges 0.2-75µm. The coating is uniform, even over sharp projections. [11]

**Conclusion**

Microencapsulation means packaging an active ingredient inside a capsule ranging in size from one micron to several millimeters. The capsule protects the active ingredient from its surrounding environment until an appropriate time. Then, the material escapes through the capsule wall by various means, including rupture, dissolution, melting or diffusion. Microencapsulation is both an art and a science. There's no one way to do it, and each new application provides a fresh challenge. Solving these riddles requires experience, skill and the mastery of many different technologies.

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