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A Systematic Review on Microencapsulation Technique and its Application

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Abstract: ***Micro-encapsulation is the process of encapsulating a compound in a small sphere called a microsphere / microcapsule. The diameter of the microspheres can range from 1 mm up to several hundred micrometers. Many different active materials have been successfully encapsulated in microballoons / microcapsules made from polymeric and non-polymer materials such as poly (ethylene glycol), methacrylate, poly (styrene), cellulose, poly (lactide), gelatine and acacia. The content of the microcapsules is released at the appropriate time using different release mechanisms according to the end use of the encapsulated product. This technology has been used in many industries such as pharmaceuticals, agri-food, printing, cosmetics, textiles and defence. In the defence sector, it has been used to create self-healing composite as well as chemical decontamination fabrics. This review highlights the main reasons for microencapsulation technology, important techniques for the encapsulation of products and applications of the technology in various fields of science and technology.***

I. INTRDUCTION

Microencapsulation is a process in which very small droplets or particles of liquid or solid matter surrounded or covered by a continuous polymer film of material[from 9] OR Micro encapsulation[1] is the process of packaging solid, liquid or gas active ingredients within a second material to protect the active ingredient from the environment. Thus, the active ingredient is considered the core material while the surrounding material acts as the shell. This technique has been used in a wide variety of industries from chemicals and pharmaceuticals to cosmetic products and printing. This is why there is a great deal of interest in micro encapsulation technology. The process of preparing microcapsules dates back to the 1950's. In the early 1960's, the micro encapsulated dyes were produced by Green and Schlickler [2,3,] which involved complex coaculation of gelatine and gum Arabic to produce carbonless copying paper. Carbonless copy paper continues to be one of the most important products to use micro encapsulation technology and is still being produced commercially today. The technologies developed for carbonless copying paper have also led to the development of various microcapule products over the years.

In the 1960s, microencapsulation of liquid cholesterol gelatin and acacia crystal with complex coacervation was announced that it is producing a heat-sensitive display material. J.

L. Fergason developed the nematic curvilinear phase (NCAP), a microencapsulated liquid crystal display system nematic liquid crystal [4]. Encapsulation technology has offered expansion of display areas and wider viewing opportunities corners. [6]

II. REASON FOR MICROENCAPSULATION

1) The main reason for microencapsulation is the continuous or long-term release of the drug
2) The method has been widely used to mask many sensory properties of tablets such as taste and smell and consequently improves patient compliance, e.g. To mask the sour taste, paracetamol, nitrofurantoin.
3) Using microencapsulation strategies, liquid tablets can be made non-fixed flowable. Powder
4) This technology can be used to transform liquid medicines in free-flowing powder.
5) Medicines that are sensitive to oxygen, moisture or lightweight, can be stabilized by microencapsulation.
6) Incompatibility of drugs can be prevented microencapsulation.
7) Evaporation of many volatile drugs such as methyl salicylate and peppermint oil can be avoided microencapsulation.
8) 7Many drugs are microencapsulated to reduce toxicity and gastrointestinal irritation, including ferrous sulfate and KCl.
9) A change in the absorption point can also be achieved by microencapsulation.
10) Toxic chemicals such as pesticides can be microencapsulated to reduce the possibility factor sensitization.
11) Bakan and Anderson reported that microencapsulated Vitamin A palmitate improved stability.[7]

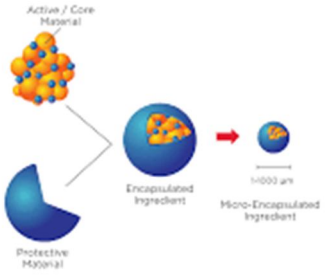


Fig :- Microencapsulation[9]

A. Advantages

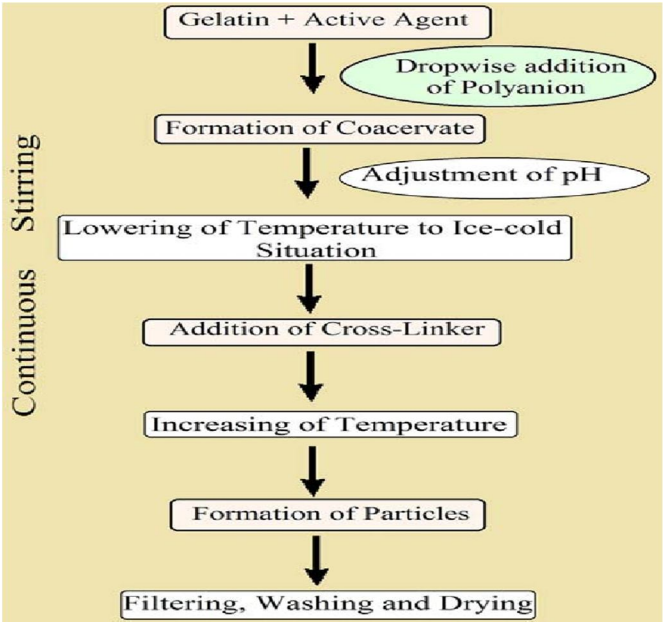
1) High production cost and smoothly controlled product powder repetition, low yield widely used and published for a wide variety of compounds with many poles and compounds in a short period of time process.
2) Heat resistance extraordinary medium mixture can use a solid product.
3) Controlled onset of active ingredients, the solubility of hydrophobic active ingredients reduces the lack of volatility of the composition.
4) Low usage price, suitable for heat-sensitive active ingredient.
5) Cost-effective methods do not require excessive temperature and do not use a natural solvent for any specific pH situation to prepare it.
6) the right alternative to heat-sensitive compound.[10]

B. Disadvantages

1) Now thermolabile compound is no longer accepted, uneven debris can form the aggregate
2) Unique based on the use of a natural solvent for high cost encapsulation efficiency on the fabric
3) Low molecular weight high cost substances can change the aggregate.
4) Climbing parameter (melting, air temperature and nozzle pressure, cooling temperature, supply flow) fast start active ingredients that are unique in the non-uniform particle encapsulation efficiency of the hydrophobic composition.
5) Unique size and modified product problems with viscous solution.
6) The price of the polystyrene foam texture product of the step by step. [10]

III. RELEASE MECHANISM

Mechanisms of drug release from microspheres are:-



1) *Degradation controlled monolithic system:* The drug dissolves in the matrix and distributes equally everywhere. The drug is firmly fixed and is released when the matrix breaks. The drug diffusion is slow compared to dissolution of the matrix.[7]
2) *Diffusion controlled monolithic system:* Here, the active ingredient is released by diffusion before butter simultaneously with the degradation of the polymer matrix. The release rate also depends on the location of the polymer degrades by a homogeneous or heterogeneous mechanism.[7]
3) *Diffusion Controlled Tank System:* Here the active ingredient is encapsulated with quick control a membrane through which a substance diffuses and the membrane wears out only after it is delivered. In this case, the breakdown of the substance does not affect the release of the drug the matrix.[7]
4) *Erosion:* Fell erosion due to pH and enzymatic hydrolysis causes the drug to be released through a specific coating material such as glyceryl monostearate, beeswax and sterile alcohol etc[12]

IV. CORE MATERIAL

A base material is defined as a specific material coated, can be liquid or solid in nature. Composition the core material can be varied, as well as the liquid core contains dispersed and/or dissolved materials. fixed the core is active ingredients, stabilizers, diluents, excipients, and release rate decelerators or accelerators. we can varying the composition of the basic material gives clear flexibility and frequent use of these functions enables the desired effective planning and development microcapsule properties.
[7,13]

V. COATING MATERIALS

The coating material must be able to form a film which is integrated with the core material; be chemical compatible and non-reactive with nuclear material; and provide desired coatings such as strength, flexibility, impermeability, optical properties and stability Coating materials used in microencapsulation methods are somewhat suitable for on-site use to change
The selection of a given coating often can be aided by the review of existing literature and by the study of free or cast films, although practical use of free-film information often is impeded for the following reasons:

1) Cast or free films prepared by the usual casting techniques yield films that are considerably thicker than those produced by the microencapsulation of small particles; hence, the results obtained from the cast films may not be extrapolate to the thin microcapsule coatings.
2) The particular microencapsulation method employed for the deposition of a given coating produces specific and inherent properties that are difficult to simulate with existing film-casting methods.
3) The coating substrate of core material may have a decisive effect on coating properties. Hence, the selection of a particular coating material involves consideration of both classic free-film data and applied results[7]

VI. COATING MATERIAL PROPERTIES

1) Stabilization of core material.
2) Inert toward active ingredients.
3) Controlled release under specific conditions.
4) Film-forming, pliable, tasteless, stable.
5) Non-hygroscopic, no high viscosity, economical.
6) Soluble in an aqueous media or solvent, or melting.
7) The coating can be flexible, brittle, hard, thin etc.

VII. TECHNIQUES TO MANUFACTURE MICROCAPSULES

A. *Physical Methods*

1) *Air-Suspension Coating:* Coating of air suspension of particles with solutions or alloys gives better control and flexibility. Particles are coated suspended in the upward airflow. They supported by a perforated plate with a different hole patterns inside and outside of the cylinder interior. Only enough air is allowed to rise through the outer surface annular space to suspend settling particles. The majority rising air (usually heated) flows inside the cylinder, causing particles to rise rapidly. Up like air the flow breaks and slows down, they resettle outside into bed and repeat the cycle moving down. Particles pass through the inner cylinder several times more than a few times little methods. The air suspension process offers a wide range of coatings material candidates for microencapsulation.

The process has the ability to carry coatings in the form of solvent solutions, aqueous solutions, emulsions, dispersions or melts into devices with a power of one 990 pounds. Core materials consist of microns or submicron particles can be effectively encapsulated air suspension techniques, but agglomeration a larger particle size is usually achieved.[7,10]

2) *Centrifugal Extrusion:* Liquids are encapsulated using a rotary extrusion head includes concentric peaks. In this process nuclear jet the liquid is surrounded by a wall solution or molten mantle.
As the jet moves through the air, it breaks up Rayleigh instability, core to droplets, each coated with a wall solution. When the drops fly, a the melt wall may be quenched or solvent may be present evaporates from the wall solution. Because the majority drops remain within ± 10% of the average diameter, settle a narrow ring around the spray itch. Therefore if If necessary, the capsules can be hardened after molding catching them in a ring-shaped tub. This the process is perfect for forming 400-2000 µm particles (16 to 79 miles) in diameter. As drops form the process isonly suitable for breaking the liquid jet liquid or slurry. High productivity can be achieved, thus it can hold up to 22.5 kg (50 lb) of microcapsules produced per nozzle per hour per head. Includes heads 16 nozzles are available.[7,10]

3) *Pan Coating:* A pan coating process that is widely used the pharmaceutical industry is one of the oldest industries methods to form small coated particles or tablets. The particles are simultaneously thrown into a pan or other device the coating is applied slowly4. A pan coating process that is widely used the pharmaceutical industry is one of the oldest industries methods to form small coated particles or tablets. The particles are simultaneously thrown into a pan or other device the coating is applied slowly larger than solid particles according to microencapsulation A size above 600 microns is generally considered essential for effective coverage and the process was comprehensive used to make controlled release beads. Typically, drugs are coated on different spherical surfaces substrates such as neparelli sugar seeds and then covered with protective layers of different polymers.[7,10]

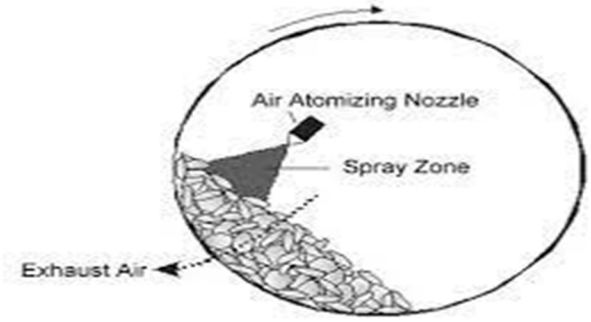


Fig:-Representation of tipical pan coating[14]

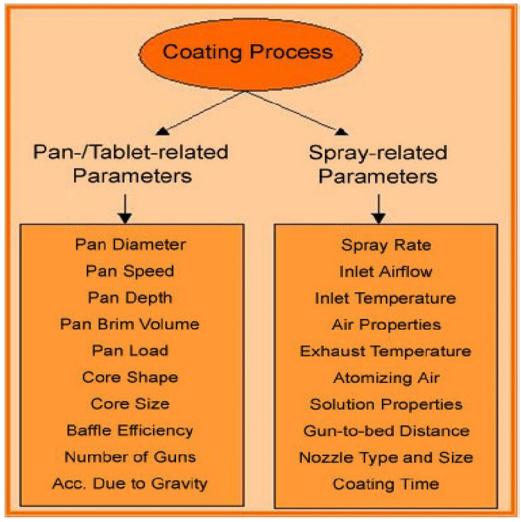


Fig:-list of variables affecting pan coating process[15]

4) *Spray–Drying :*Spray drying works as a microencapsulation technique when the active material is dissolved or suspended a in the molten or polymer solution and is trapped within the dried particle The main advantages are the ability to handle labilethe materials were dried due to the short exposure time In addition, the operation is economical. In a modern shower room the viscosity of the solutions sprayed on the dryers can be up to 300 mPa.sIn practice, microencapsulation is by spray drying is carried out by diffusion in the coating of the core material solution in which the coating agent is dissolved and where the core material is insoluble, and then by the mixture is sprayed into the air stream. Usually air heated, provides the necessary latent heat of vaporization remove the solvent from the coating to form microencapsulated product. equipment parts of a standard spray dryer contain air heater, sprinkler, main shower, blower or fan, cyclone and product collector.[9,10]

VIII. APPLICATION FIELDS OF MICROENCAPSULATION

Many businesses, particularly the food and pharmaceutical sectors, use microencapsulation technology extensively because it can improve the solubility, stability, and characteristics of substances with controlled release, such essential oils, medications, enzymes, antioxidants, etc. Thus, the emphasis of this section is regarding the use of microencapsulation in various sectors.

IX. APPLICATIONS IN THE FOOD INDUSTRY

Functional ingredients are used in the food business to enhance the flavor, color, and texture characteristics of products and to increase their shelf life.

Furthermore, components with practical health advantages, such probiotics and antioxidants, are much sought for (Borgogna et al., 2010).

Unfortunately, the majority of these compounds are easily broken down by environmental conditions and have low stability. Making bioactive molecules with great stability is therefore crucial. Microencapsulation represents a potential solution to these problems. A lot of study has been done recently on the manufacturing of very effective microcapsules and how the food sector can use them.

A. Beverages

Burin et al. (2011) assessed the anthocyanin's stability in an isotonic soft drink system when it was encapsulated in several carrier agents. Pigments that dissolve in water called anthocyanins are from greenery. Typically, these pigments are employed as colorants in meals and beverages due to their strong colorant strength, low toxicity, and great solubility in water (Ersus and Yurdagel, 2007). Furthermore, a number of research have demonstrated the significant anticarcinogenic and antioxidant qualities (Wang and Xu (2007); Rosso and colleagues, 2008). Anthocyanins, however, are unstable pigments that can break down into molecules without color by a variety of elements, including as oxygen, light, temperature, pH, and the dietary matrix (Xu and Wang, 2007). In light of this, microencapsulation has been applied to improve these compounds' stability (Giusti plus Wrolstad (2003)).

B. Baked Goods

Rocha et al. (2012) used a modified starch as the encapsulating medium to create lycopene microcapsules using spray-drying. By putting the microcapsules on cake, their functionality was ascertained. One carotenoid found in a variety of fruits and vegetables is lycopene. It is a common food coloring used in red foods.However, because of its high amount of conjugated phenols, lycopene is readily oxidized during storage. two bondings. Microencapsulation was predicted in this study to improve lycopene stability. The findings indicated that cake produced with microcapsules had a higher pigment content than regular cake.

C. Meat and Poultry

Probiotics were investigated by Muthukumarasamy and Holley (2006) as a potential way to boost the nutritional content of dry-fermented sausages. Probiotic organisms, however, have a poor survival rate in fermented meals, according to numerous research (Shah et al., 1995; Kailasapathy and Rybka, 1997; Lücke, 2000; Shah and Ravula, 2000). Using the microencapsulation approach, bacterial cells were kept within a protective polymer membrane or matrix to increase their survivability (Audet et al., 1993). The outcomes demonstrated the potential application of microencapsulated Lactobacillus reuteri in dry fermented foods by preventing cell viability loss upon drying without compromising product quality.

D. Dairy Products

Anjani et al. (2007) created Flavourzyme microcapsules with different wall materials to be used in cheese manufacturing. Longer ripening times are needed for low-moisture cheese kinds like cheddar to acquire the right flavor, texture, taste, and scent.

According to McSweeney (2004), exogenous enzymes are added to cheese to speed up the maturing process because typical cheese maturation happens quite slowly. On the other hand, adding enzymes directly causes poor yield, poor dispersion of the enzymes, loss of enzyme, and poor quality cheese. Flavourzyme was able to be distributed evenly because to microcapsules that were introduced to milk during the manufacturing process.

X. APPLICATION IN PHARMACEUTICAL INDUSTRIES

The pharmaceutical sector has made extensive use of the microencapsulation technology for flavor masking, improved stability, and controlled release of medications (Mendanha et al., 2009).

The application of microcapsule formulations for the colon-specific delivery of a water-soluble peptide medication was investigated by Arimoto et al. in 2004. Peptides often have low permeability through polymeric membranes and are heat-sensitive. Therefore, the goal of this work was to maintain the required permeability that would enable a delayed-release profile for macromolecular medications while also maintaining the stability of heat-sensitive pharmaceuticals. The poly(EA/MMA/HEMA) with a molar ratio of 95:85:40 demonstrated good film-formability at 40°C, according to the results. These circumstances might be suggested as a suitable method for the preparation of water-soluble medication-containing delayed-release microcapsules intended for colon-specific delivery.

XI. DIFFERENT VIEWPOINTS BETWEEN FOOD AND PHARMACEUTICAL APPLICATIONS

Microcapsules are currently used extensively in the pharmaceutical and food industries. The objectives of microencapsulation in the food and pharmaceutical industries are compared and contrasted in Table 1. Microencapsulation is utilized in the food sector to lower costs, improve compound stability, hide unwanted tastes, and enhance chemical release qualities. Microencapsulation is a technique used in the pharmaceutical business to provide targeted medication delivery, improve drug release qualities, boost stability, and hide harsh taste. In the food sector, producing high-efficiency microcapsules at a low cost of manufacture is the major goal. Nevertheless, the goal of the pharmaceutical industry is to produce highly effective microcapsules that, at any cost, can transport medications to particular organs.

[16]

XII. CONCLUSION

With the intention of organizing the disorganized information on the subject that is available in the literature, a classification of the research done on PCM microencapsulation is offered in this work. The many sections offered cover the various PCM kinds, the various shell materials that are utilized, the encapsulating processes, the most popular methods for characterizing them, and the primary uses.

PCM can be either organic or inorganic; paraffin and fatty acids have received a lot of attention in the encapsulation of primarily organic PCM to date. The microencapsulation of salts and salt hydrates has only been reported by a few researchers recently. There are only few known manufacturers of MPCM. Phase change slurries (PCS) are what MPCM are known as when they are utilized as a heat transfer fluid.

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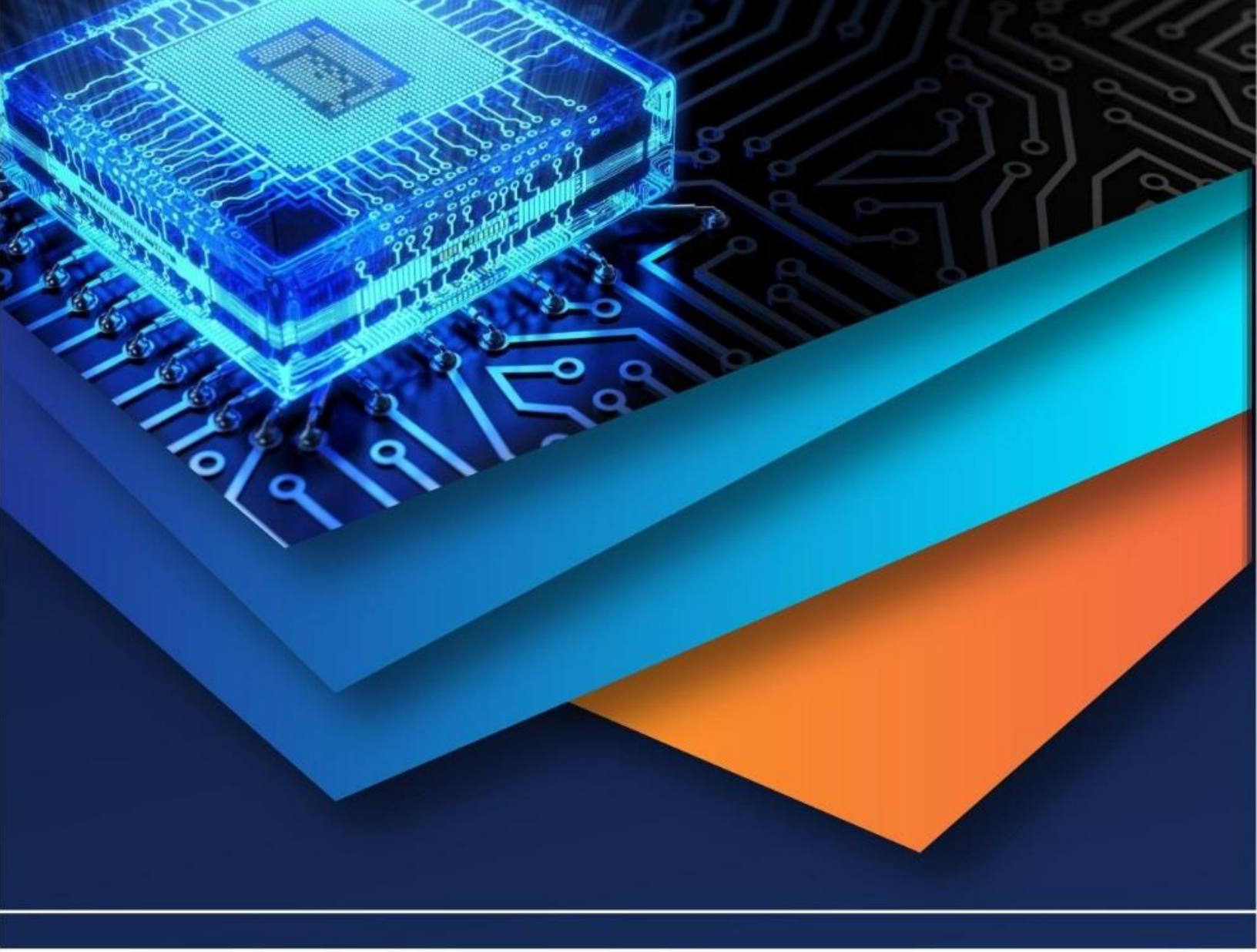

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