AIRO JOURNALS
Free / Unpaid
Peer Reviewed
Multidisciplinary
International

ISSN: 2320-3714
Volume 3 Issue 2
August 2023
Impact Factor: 10.2
Subject Chemistry

"An Analytical study of the Making polymer hybrid materials and using them in medicine"

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Abstract:

Polymer hybrid materials have emerged as a promising class of materials with diverse applications in medicine. This analytical study explores the synthesis, properties, and biomedical applications of polymer hybrid materials, with a particular focus on their potential use in the medical field. The study begins by investigating the various methods employed in the fabrication of polymer hybrids, including blending, copolymerization, and grafting techniques. Different types of polymers, such as biodegradable polymers, natural polymers, and synthetic polymers, are considered for their ability to be combined with other materials to create versatile hybrids. Furthermore, the study delves into the characterization techniques used to evaluate the structural, mechanical, and biological properties of polymer hybrid materials. Analytical techniques, such as scanning electron microscopy (SEM), X-ray diffraction (XRD), and Fourier-transform infrared spectroscopy (FTIR), are discussed to assess the morphology and composition of the hybrids. In the context of medical applications, the study highlights the potential of polymer hybrid materials in drug delivery systems, tissue engineering, and medical implants. The controlled release of therapeutic agents

from these hybrids demonstrates their potential in targeted drug delivery and personalized medicine. Moreover, the biocompatibility and biodegradability of polymer hybrids make them suitable candidates for tissue engineering scaffolds, promoting cell adhesion, proliferation, and differentiation.

Keyword: - polymer, composition, semonstrates, Hybrid, Scalability.

Introduction

Polymer hybrid materials have emerged as a significant area of research at the intersection of materials science, chemistry, and medicine. These materials combine the advantageous properties of polymers with those of other substances, such as nanoparticles, metals, ceramics, or natural materials, resulting in a diverse range of multifunctional materials with unique characteristics. In recent years, the integration of polymer hybrids in medicine has garnered considerable attention due to their potential to revolutionize various biomedical applications.

Traditional polymers have been extensively used in medicine, serving as drug delivery carriers, tissue engineering scaffolds, and medical device coatings. However, their limitations, such as inadequate mechanical strength, limited bioactivity, and lack of targeted drug delivery capabilities, have spurred the development of hybrid materials to overcome these challenges.

The incorporation of nanoparticles and other nano scale components into polymers offers the opportunity to enhance their mechanical properties, biocompatibility, and biodegradability. Moreover, the fictionalization of polymer hybrids with specific legends allows for targeted drug delivery to specific cells or tissues, reducing systemic side effects and enhancing therapeutic efficacy.

This analytical study aims to explore the state-of-the-art in the development of polymer hybrid materials and their applications in medicine. By comprehensively analyzing the literature, we intend to highlight the key advancements in the field, the underlying principles governing the synthesis of these materials, and the implications of their use in medical applications. Additionally, we will assess the challenges and opportunities associated with the integration of polymer hybrid materials into the medical landscape.

Review of Literature

MalekAljnaid& Raid Banat (2021) Polypropylene (PP) was studied with and without the use of two coupling agents to see how adding olive pomace flour (OPF) affected the material's mechanical, water absorption, morphological, and thermal characteristics. The impact strength increased to 141 J/m as the proportion of coupling agent increased. The two coupling agents enhanced the OPF/PP composite's tensile and flexural characteristics. When OPF was added to pure PP, the features were mitigated, demonstrating the usefulness of the coupling agents. The water absorption property of PP was improved by 1.36% after adding the OPF, but was reduced to 0.78% after adding a coupling agent. Crystallization enthalpy (H c = 133 J/g), melting enthalpy (H m = 123 J/g), and crystallinity percent (X c = 59%) all decreased from their clean PP counterparts when filler and coupling agents were introduced into the composite. In this investigation, we found that, with the right amount of coupling agent applied to the composite, OPF may serve as a useful reinforcement for PP, improving its mechanical and morphological qualities.

Hsissou, Rachid, et al., (2021) the present study presents the results of our development and exploration of a thorough analysis of advanced composite materials based on thermoplastic polymers, elastomer polymers, and thermosetting polymers. These high-tech composites' formulations included organic, mineral, and metallic fillers in addition to the organic and inorganic fibre reinforcements. Polycarbonate, polyhexamethylenesebacic, polyether sulfone, polyether ether ketone, polyether ketone ketone, polyether imide, polyethylene terephthalate, phenoplasts, epoxy resin, and polyurethane are just some of the macromolecular matrices we've developed and synthesised and shown here. Advantages of composite material formulations include superior mechanical performances, high heat resistance, outstanding fire behaviour, high impact resistance, best abrasion resistance, extraordinary electric insulation, and good stiffness. Then, the process of creating composite materials from scratch was outlined.

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Sorting based on the time of reinforcing

Based on the type of reinforcement, composite materials can be put into the following groups:

- Materials made up of small pieces
- Composite materials in which the bits are arranged in different ways
- Fibrous is a Mixtures of things
- Composite materials with fibres that are arranged in different ways
- Composites with a preferred way of aligning the fibres
- Fibres in composite materials that are aligned in only one way
- Composite materials with fibres that run in both directions or that are woven
- In addition to that, composite materials can also be put into the following groups:
- Materials made of carbon and carbon
- Mixtures of different materials
- Fiber-reinforced composite elements are put together.
- Materials made of laminar composites

Based on the form and size of the reinforcing material, composites are also called whiskers, flakes, filled composites, cermet or ceramal, particle-reinforced composites (large-particle and dispersion-strengthened composite), and sandwich panels composite.

The process of making composite materials

The most common way composite materials are made is as follows:

1. Process of hand lay-up Process of spray lay-up
2. Pressing into shape
3. The process of moulding with resin transfer
4. The process of injection moulding
5. The process of pultrusion
6. Winding up the filament

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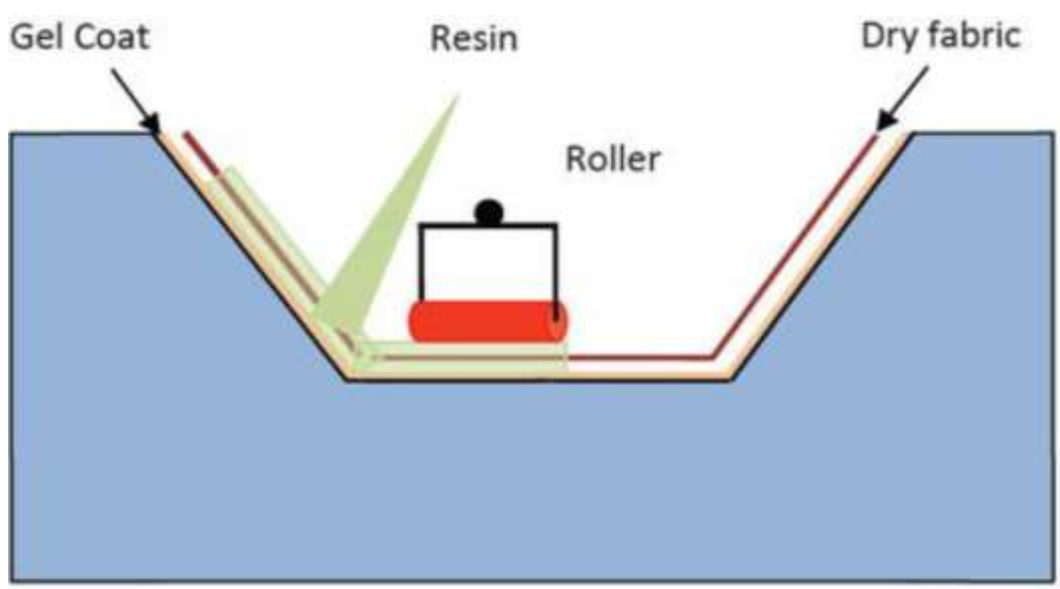
7. Moulding with a hoover
8. Pressurised bag-making
9. Moulding in an autoclave
10. Putting resin into a film

Method for hand lay-ups

The contact moulding process, which is done by hand, is the simplest, oldest, and fastest way to make composite materials, especially fiberglass-resin composites.

Fig. 1 shows the plan for how this method works. In this process, release gel is first put on the surface of the mould to stop the plastic material from getting close to the surface.

To get better surface finishes on the product, the bottom and top of the moulded plate are lined with plastic sheets of the right thickness. Reinforcing material is then injected in the form of chopped strand mats or woven mats, which are then cut to the size of the mould and placed on the mould surface after the perspex sheet. Specific polymeric materials of thermosetting glue in liquid form in the right amount are used as a curing agent and spread evenly with a brush.



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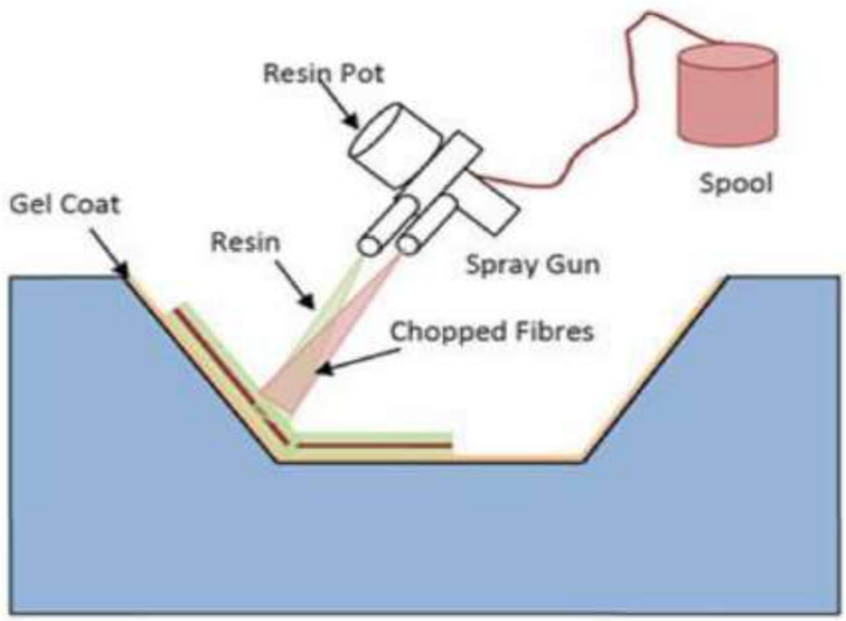
The spray lay-up method

This method builds on and improves the hand lay-up process shown in Fig. 2. In this process, a spray gun is used to spread pressurised resin and reinforcing material (glass roving) in the form of broken fibres.



Process of compression moulding

It is the most common and widely used method of moulding composite materials to make a wide range of different goods with different properties. This is a closed moulding process in which high force (pressure) and heat are used to make raw materials into the right shape, like pneumatic and hydraulic seals, by pressing them into a metal mould. The plan for this process is shown in Fig. 3. The raw material added to the mould is heated until it becomes soft and pliable, and then the mould is shut for a certain amount of time.

ISSN: 2320-3714
Volume 3 Issue 2
August 2023
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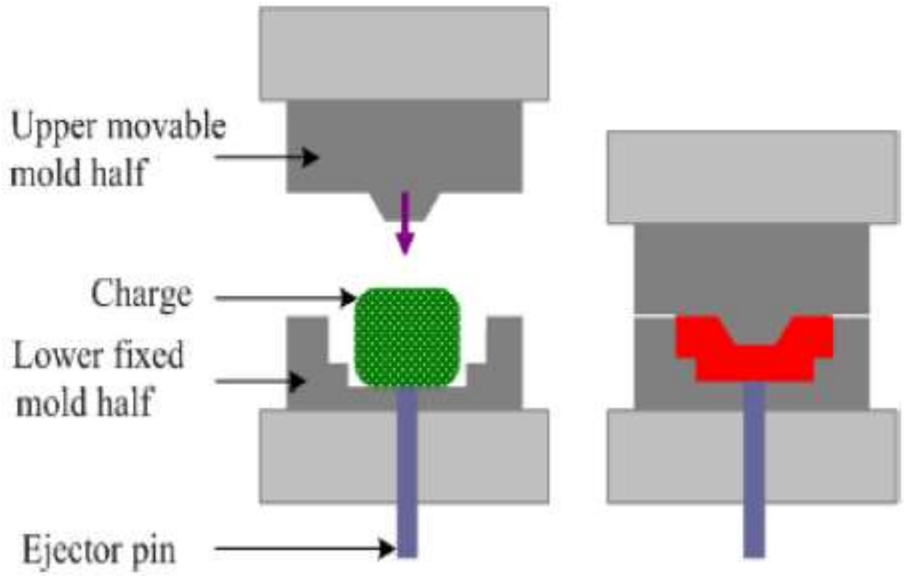

Uses of mixed materials in medicine

By making them biocompatible, polymer composite materials are now being used in different biomedical implants and the making of medical products. In addition, the different types of modern composite materials are used in other places because they are strong and don't catch fire.

Use for orthopaedics

Some polymeric materials that are biocompatible are used more and more in orthopaedics for things like fixing plates and screws when a bone breaks, replacing a hip joint, bone grafting, bone cement, repairing finger joints, repairing and replacing tendons and ligaments, and so on. From an orthopaedic point of view, it is hard for different study groups to come up with and design the special materials they need. Different orthopaedic uses call for the following combination materials.

Replace the knee

A better material for this would be a hybrid made of polyethylene or polyethylene with a very high molecular weight that has carbon fibres as reinforcement. Most bone implants are stressed unevenly, which is called "stress shielding" or "stress protection." In this case, it's best to use materials with a low modulus and high strength, like polymer composites. Some experts say that ultra-high molecular weight polyethylene (UHMWPE) reinforced with carbon fibre is a better choice because it is stiffer, doesn't stretch, and is very strong. Polyether ketone (PEEK) hybrid materials that are strengthened with carbon fibre can stand up to wear better. So, carbon fibre reinforced with UHMWPE (CF/UHMWPE), carbon fibre reinforced with epoxy resin (CF/epoxy), and carbon fibre reinforced with PEEK (CF/PEEK) are the most common composite materials used for knee replacements.

Replace the hip

Most hip replacements are done with composite materials made of epoxy glue, polyethylene, and polysulphone as the matrix phase and carbon fibre as the reinforcement. Polymers are split into two groups based on how long they last in the human body: bio-stable and soluble. PE, PMMA, and PEEK are all bio-stable polymers, while PCL, PGA, PLA, PGA, and PLGA are all biodegradable polymers. Simple plastics are not the best choice for hip replacements because they are not as strong and have a lower modulus of elasticity. Because of this, hybrid materials have been chosen over polymers that are made directly. Here are some examples of the hybrid materials that are used for hip replacements:

Bone glue

People think that the best material for bone cement is a polymer composite made of carbon fibres strengthened with UHMWPE and Kevlar fibres reinforced with Teflon. PMMA is the most common type of bone cement. It is most often used to fix implants in orthopedic and emergency surgery. In fact, PMMA works well as filler for spaces or holes. It holds the graft materials against the bone and acts as a "grout." Even though bone cement doesn't stick to anything, it can be tightly packed between the uneven surface of the bone and the prosthetic and acts as a glue. Calcium phosphate cements (CPCs) and glass polyalkenoate cements (GPCs) are the most popular commercial bone cements. They work well in a number of orthopaedic and dental applications. CPCs are mostly used in cranial and maxillofacial surgeries because they are safe and have low mechanical strength values. Even though they work well in orthopaedic uses, they still need to be improved so that they have fewer bad effects [35].

Bone plates and screws:

PLA is known as a bioresorbable polymer because it is easy to find and has great qualities. Since PLA takes longer to break down (between 6 weeks and several years), it can be used to implant and strengthen bone and ligaments while they heal. It is the only polymer that can cause new bone to grow while the implant slowly breaks down.

- When PLA is used, bone in the broken area starts to grow back and gets stronger.

PGA is a biodegradable polymer that has many of the same qualities as PLA. Like PLA, it is also an important biodegradable polymer. It works much better in cortical bone than the metal alternatives. PCL is also a very important biodegradable polymer. It belongs to a group of polyesters called aliphatic polyesters. It is a semi-crystalline polymeric material with a freezing point of around 60 C. Direct condensations makes PCL with a smaller molecular weight, while ring-opening polymerization makes PCL with a higher molecular weight. But PCL with a lower molecular weight breaks down faster and has less power than PCL with a higher molecular weight, which breaks down less quickly and is more stable. The biggest problem with PCL is that it is the softest biodegradable polymer and takes the longest to break down. It is used as a bone plate because it is safe, has a high mechanical strength, and breaks down at a rate that is not too fast. Also, it can be bought for less money.

- Metals are the cause of stress-protection osteoporosis because they are more elastic than normal human bone.

The difference in stiffness between bone and metal is what stops the healing process, and the healing process can lead to decline and osteoporosis in bone. The moduli of unreinforced thermoplastics are much lower than those of bone, making them too weak for the best bone healing. So, fiber-reinforced laminated composite material is now being used instead of metal plates and screws as a good material for internal fracture repair implants. Bone grafts can't be made out of

ISSN: 2320-3714
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carbon fibre reinforced composite materials because they rust. When PBT and nylon are reinforced with short carbon fibre composites (CFRP), the material can be made to have a low elastic stiffness, which helps the body heal. The right choice of material, along with the theory of lamination and the science of micromechanics, makes it easier to create and make new laminated composite materials with specific essential properties that can be used to fix broken parts of bone. By using a specific, unique moulding method, complex-shaped composite materials like screws, plates, and pins that are implanted in bone fracture areas can be made. It has been found that using short carbon fibre as a reinforcing material in PBT and nylon composites makes them a better choice for orthopaedic use because it speeds up the mending process [36–38].

Use in dentistry

Composites that are used in dentistry are called resin-based composites or filled resin composites. Dentists often use them as fillings and sealants. Some of these materials, like composites, have qualities like micro-mechanics that make them useful for filling small cavities where amalgam fillings don't work as well.

Dimethylglyoxime is sometimes added to the process of making it to improve some of its physical features. Most of the composite materials used by dentists are based on resins like bisphenol-A-glycidyl methacrylate (BISGMA), urethane dimethacrylate (UDMA), and semicrystalline form of polyceram (PEX). Silicon dioxide is used as the filler material, which gives the material properties like higher strength, resistance to wear and shrinkage, better transparency, fluorescence property, improving colour, and reducing the exothermic reaction.When silane is added, the link between the base and reinforcing phases gets stronger.

Zirconia-silica and zirconium oxide in nanoparticle form are also used as filler elements. The micro-fillers of silicone dioxide make the material stronger and more resistant to wear. Hybrid filler materials, which include both macro- and micro-filler, are sometimes used to improve mechanical strength and decrease thermal expansion. Nano hybrid filler materials have better qualities like resistance to wear, mechanical strength, and the ability to be polished [40–42].

Uses of tissue engineering

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Most of the time, biodegradable manmade polymeric materials are the best choice for tissue engineering. In tissue engineering, polylactic acid (PLA), polyglycolic acid (PGA), and the co-polymer of polylactid-co-glycolic acid (PLGA) are the most commonly used manufactured biodegradable polymeric materials.

The biodegradable composites of polymer matrix with bioactive inorganic material as filler, mostly hydroxyapatite or bioactive glass, in the form of fibres or particulates, improve the physical, mechanical, and biological properties, especially the ability to tailor their own structure and decrease the rate of degradation to the specific need at the implant site.

Conclusion

Composite materials have great properties and can be used in many different areas. They are considered to be modern materials of good luck. Using composite materials in medicine has many benefits, such as a lower cost, better connection with the body, and a longer life cycle. Polymer composite materials work better for tissue engineering, dentistry, wound repair, orthopaedic surgery, joint replacement, hip replacement, and other uses. In recent years, bio-composites have been used to make medicines, medical equipment, and packaging for medical products. Melt-extrusion, solution mixing, electro-spinning, latex technology, and in situ procedures, etc., are some of the current ways that polymer matrix composites are made. The use of composite materials in medicine is likely to be inspiring, and new devices made of polymer composite materials are used during surgery and make prostheses more stable.

Even though these materials have some advanced qualities, like being biodegradable, not causing inflammation, being biocompatible, and being able to stick to cells better, they also have some problems, like giving off acidic waste and having poor cell affinity. Before polymer composite materials can be sold commercially, these problems need to be fixed, and more study needs to be done on their design and development.

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