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Engineering Polymer-Based Barrier Films for Infection Control in Surgical Environments

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Abstract

It is important to keep a sterile surgical area as a measure of infection prevention after an operation. Traditional protective materials tend to not be long-lasting, are not uniformly protective in their behavior, and have just limited biocompatibility. The use of barrier films made of polymer has emerged as a ground-breaking solution to the contemporary operating rooms. These movies prevent the entry of microbes, are impervious to moisture, and endure mechanical forces during surgical operations and are easy to manipulate by surgeons. Innovation in polymer chemistry, nanocomposite production, surface functionalization, and scalable production have created highly efficient customizable films with good antimicrobial, antifouling, and fluid-impermeable properties. Innovative smart product systems can react to environmental stimuli, laminate films formulated through multilayers offer structural integrity as well as selective permeability and bio-based possibilities cause less harm to the environment without compromising on protection. They have now been used in surgical drapes, instrument covers, wound barriers, and personal protection equipment and have proved to increase sterility assurance and the protection of clinicians. New digital manufacturing and flexible fabrication technologies enable the control of the thickness of the film, microstructure, and surface energy to meet the requirements of individual surgeries. Several challenges have still to be faced, though, including regulatory compliance, waste management, long-term biocompatibility and cost optimization. Further interdisciplinary studies need to be conducted to enhance polymer preparations, appraise clinical efficacy, and develop strong criteria for film-based infection control preparations. Engineered polymer barrier films, also known as the combination of material science and surgical practice, are a potential future avenue toward the health care of safer, more reliable, and recognized infection control.

Keywords: Polymer barrier films, infection control, surgery, antimicrobial polymers, nanocomposites, sterile drapes, polymer engineering, biomedical materials, smart films, surgical site infections prevention

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INTRODUCTION

SSI is one of the major issues of the operating unit that raises the morbidity of patients, hospitalization, and expenditures. Sterilization procedures, advanced apparatus, and aseptic procedures still fail to assuage the serious ordeal of contamination by fluids, aerosols, instruments, and wounds despite complex procedures such as aseptic. Polymer based barrier films are also rising in attraction due to their ability to block transmission of microbes, improve sterility and resistance to physical and chemical risks. Advanced films are achievable using modern polymer engineering, surface modification and nanotechnology which combine mechanical strength, biocompatibility and antimicrobial activity [1].

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It is believed that high-performance barrier films, in surgical draping, gowning, wound dressing, packing, and instrument shells, are becoming more frequently used in hospitals. These movies are smooth, less porous, and have adjustable barrier properties as opposed to conventional woven fabrics. They may be optimized to be permeable, hydrophobic or hydrophilic and even sterilizable. Also, biodegradable and bio-based polymers tend to comply with the need to be environmentally sustainable [2].

From a research perspective, continuous efforts are being made to improve the functional performance of polymer-based barrier films through innovations in material design and fabrication technologies. Researchers are investigating novel polymer blends, multilayer structures, nanocomposite films, and surface modification techniques to enhance barrier efficiency against bacteria, viruses, and body fluids while maintaining flexibility, breathability, and patient comfort. The incorporation of antimicrobial nanoparticles, bioactive agents, and controlled-release systems has further expanded the potential of these films to provide active protection rather than serving solely as passive physical barriers. These advancements aim to reduce the incidence of surgical site infections while improving the overall safety and effectiveness of surgical procedures [3].

Recent research also focuses on developing smart and sustainable barrier films capable of responding to environmental stimuli such as pH, temperature, moisture, or microbial contamination. In addition, biodegradable and bio-based polymers are gaining considerable attention as environmentally friendly alternatives to conventional petroleum-based materials, supporting global initiatives to reduce medical waste. Future investigations are expected to integrate nanotechnology, advanced manufacturing techniques, computational material design, and artificial intelligence to optimize polymer properties, predict material performance, and accelerate the development of next-generation barrier films. Nevertheless, challenges related to large-scale production, regulatory approval, long-term biocompatibility, cost-effectiveness, and clinical validation remain important areas for future research before these advanced materials can achieve widespread clinical implementation [4].

The review examines and discusses the underlying engineering concepts, material developments, and clinical uses of polymer-based barrier films to prevent infection in the surgical environment. It also recaps modern advances in polymer chemistry, nanocomposite structure, antimicrobial approaches, and manufacturing films and states the critical points in relation to performance analysis and research perspectives.

MATERIAL REQUIREMENTS FOR SURGICAL BARRIER FILMS

The barrier films that are applied in surgery are required to be in strict specifications, which can resist any microbe and fluid. Their major specifications are low porosity, mechanical durability, chemical inertness, tearing resistance and compatibility with the sterilization procedure like autoclaving, ethylene oxide, gamma irradiation, and plasma sterilization [5].

Mechanical Performance

Important is mechanical integrity to ensure the film remains intact in procedures. The most important are tensile strength, puncture resistance and flexibility. Polyether based polymers – such as polyethylene (PE), polypropylene (PP), polyurethane (PU) and polyvinyl chloride (PVC) – are excellent tough and tear resistant polymers. The composites are multilayered such that the film remains thin enhancing strength thus making the barrier lightweight and comfortable [6].

Fluid and Microbial Barrier Properties

The primary objective of barrier films is to prevent micro-organisms and fluids intrusion. Effective protection is obtained through hydrophobic polymers, microporous structure and vapor impermeable coating. Research indicates that polymers which have crystallinity and surface energy with control can greatly lower adhesion and wicking of bacteria [7].

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Biocompatibility and Sterilization Endurance

Biocompatibility is used to guarantee that materials do not cause untenable responses in the tissues or poisoning during surgery. Polymers ought to be sterilized without degeneration. New examples of polyolefin formulations do not degrade during gamma exposure, whereas silicone-coated films do not lose their elasticity at the end of sterilization by plasma [8].

Surface Characteristics and Functional Performance

Surface characteristics play a crucial role in determining the overall effectiveness of surgical barrier films [9]. The surface chemistry, roughness, wettability, and surface energy of polymeric materials significantly influence microbial adhesion, protein adsorption, and fluid interaction. Smooth and low-energy surfaces reduce bacterial attachment and biofilm formation, thereby minimizing the risk of contamination during surgical procedures [10]. Conversely, controlled surface modifications can enhance desirable properties, such as hydrophobicity, hydrophilicity, anti-fogging capability, and improved adhesion to skin or medical devices, depending on the intended clinical application.

CATEGORIES OF POLYMERS USED IN BARRIER FILM ENGINEERING

Many polymer classes are employed to make barrier films and tailor the functionality to be desired, where each of them has certain structural and physicochemical properties.

Polyolefins

Polyethylene and polypropylene are preferred due to their chemical resistance, processing, as well as adjustable crystallinity. High density polyethylene (HDPE) can provide a high barrier performance whereas low density polyethylene (LDPE) is more flexible. The precisely controlled chain architecture with improved barrier properties is possible through metallocene catalyzed polymerization [11].

Polyurethanes

Elasticity, toughness and breathability are combined into polyurethanes. Their segmented block copolymer form allows the manufacturers to optimize mechanical properties and water–vapor transmission. Medical grade PU films are found in the wound dressings, drapes and protective apparel where they also offer comfort without affecting the sterile property [12].

Polyesters and Copolyesters

PET and copolyesters are of high tensile strength and thermal stability. They are also suitable as sterile packages and covers of instruments because of their low gas permeability and inability to degrade by microbes. PET coatings are coextruded films that in turn provide smooth surfaces and clear visibility of the tools that can be inspected [13].

Silicone Polymers

Silicone rubbers provide biocompatible, conformable and soft films. They are highly thermal and their hydrophobicity is appropriate to the protection of drapes and wounds. Silicone films may also include antimicrobial agents including silver nanoparticles and quaternary ammonium salts [7].

Bio-Based and Biodegradable Polymers

Sustainability drives the creation of bio-based substitutes such as polylactic acid (PLA), polyhydroxyalkanoates (PHAs) as well as cellulose derivatives. Such polymers can be made into transparent and low porosity films that can be used in disposable surgical parts. Despite biodegradability being an advantage, mechanical performance is still a challenge to some of the formulations [14].

Nanocomposite Polymer Systems

Nanocomposite polymer systems have emerged as one of the most promising classes of materials for next-generation surgical barrier films due to their ability to simultaneously enhance mechanical strength, barrier performance, and antimicrobial activity [15]. These materials are produced by incorporating nanoscale fillers, such as silver nanoparticles (Gaps), zinc oxide (Zano), titanium dioxide

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(TiO_2), graphene oxide, nano clay, and cellulose nanocrystals, into polymer matrices including polyethylene (PE), polypropylene (PP), polyurethane (PU), and polylactic acid (PLA). The uniform dispersion of nanoparticles creates a more tortuous diffusion pathway for gases, moisture, and microorganisms, thereby significantly improving barrier efficiency while preserving the flexibility and lightweight nature of the films [16].

NANOCOMPOSITE BARRIER FILMS

More complete barrier films are now possible using nanotechnology. Now that we add small fillers on the nanoscale scale on the backbones of the polymers, we have stronger nanocomposites, which are more effective in fighting microbes, and they further prevent gases and liquids at the nanoscale.

Nanoparticle-Reinforced Polymers

The common inorganic nanoparticles include silver, zinc oxide, titanium dioxide, silica which are incorporated into films to enhance their antimicrobial capability as well as mechanical capability. Silver nano-particles are known to kill numerous germs by rupturing their cell walls and preventing their multiplication [17]. The particles of silicate are layered in such a manner that the gas is prevented from moving through them as the diffusion path becomes more convoluted.

Polymer–Nanofiber Hybrid Films

Nanofibers as well as electrospun provide films with an enormous surface area and variable holes. When such nanofibers are made to support a film, it becomes a breathable and well-filtering film. That qualifies them as the best in the form of surgical masks, gowns, and air-barrier components. We combine comfort and protection in marrying a polymer core that is sturdy together with a nanofiber layer [18].

Graphene-Enhanced Films

Graphene oxide and reduced graphene oxide cause films to be stiffer, chemically stable as well as antimicrobial. They consist of sheets of excellent fluid and microbe blocking effect. These hybrids of graphene have the potential to heat when subjected to modest light to be able to kill germs [19].

Smart Nanocomposite Barrier Films

Smart nanocomposite barrier films represent a new generation of advanced surgical materials designed to provide both passive protection and active responses to changes in the clinical environment. These films integrate functional nanomaterials with polymer matrices to create stimuli-responsive systems capable of reacting to variations in temperature, pH, moisture, light, or microbial contamination. Such responsive behaviour enhances infection prevention by enabling the controlled release of antimicrobial agents only when required, thereby improving therapeutic efficiency while minimizing unnecessary exposure to antimicrobial compounds [20]. Smart barrier films also exhibit self-cleaning, self-healing, and anti-biofouling properties, which help maintain their structural integrity and protective performance during prolonged clinical use.

Recent developments have incorporated nano sensors, antimicrobial peptides, and responsive nanoparticles into polymeric barrier films to facilitate early detection of microbial growth and localized antimicrobial action [21]. These multifunctional materials have shown considerable potential for applications in surgical wound dressings, implant coatings, sterile packaging, and protective medical apparel. Furthermore, advances in nanotechnology and polymer engineering have enabled the fabrication of smart barrier films with improved mechanical strength, excellent biocompatibility, enhanced moisture regulation, and prolonged antimicrobial activity. Although these technologies remain largely in the research and developmental stage, continued progress in material optimization, manufacturing scalability, regulatory approval, and clinical validation is expected to accelerate their translation into routine surgical practice, contributing to more effective infection prevention and improved patient outcomes [22].

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SURFACE ENGINEERING STRATEGIES FOR INFECTION CONTROL

Coating a film reduces the number of microbes that can adhere to it, forming biofilms impeding an important process of maintaining bodily cleanliness of surgical sites.

Hydrophobic and Superhydrophobic Surfaces

Water repulsive designs on films are achieved with coating which reduces surface energy, fluorinated polymers, and minute textured patterns. The water-repellent (super hydrophobic) films, which are emulated after the lotus leaves, lower the surface to which bacteria adhesion can occur [23].

Antimicrobial Coatings

Antimicrobial surfaces may be planned in two ways; passive and active. Passive coatings prevent the adhesion of microbes through water friendly brushes or zwitterionic polymers. Active coatings emit substances that in fact kill the microbes now of object contact like quaternary ammonium salts, metal ion, or enzymes [24].

Stimuli-Responsive Films

The smart barrier films vary according to the changing environment. During longer surgeries thermos-responsive polymers regulate the breathable nature of the film. Antimicrobials are produced as a reaction to pH only in cases where the risk of infection increases. This is a specific measure that reduces unnecessary drug discharge and reduces cytotoxic threat [25].

Plasma Surface Modification

Plasma surface modification has emerged as an effective and environmentally friendly technique for improving the surface properties of polymer-based barrier films without altering their bulk characteristics. Plasma treatment introduces functional groups, such as hydroxyl, carboxyl, and amino groups onto the polymer surface, thereby enhancing surface wettability, adhesion, and biocompatibility. This modification also facilitates the immobilization of antimicrobial agents, bioactive molecules, and protective coatings, resulting in improved resistance to microbial colonization and biofilm formation. In addition, plasma-treated surfaces exhibit enhanced coating stability and durability, making them highly suitable for surgical drapes, wound dressings, and sterile medical packaging. Owing to its solvent-free nature and precise surface control, plasma technology has become an increasingly important strategy for developing high-performance infection-resistant barrier films [26].

Bioactive Surface Functionalization

Bioactive surface functionalization is an advanced surface engineering strategy that enhances the biological performance of polymer barrier films through the incorporation of antimicrobial and biocompatible molecules onto the material surface. Various bioactive agents, including antimicrobial peptides, enzymes, chitosan, silver nanoparticles, zinc oxide nanoparticles, and naturally derived phytochemicals, can be immobilized on polymer surfaces to provide continuous protection against bacterial, fungal, and viral pathogens [27]. Unlike conventional antimicrobial coatings that rely solely on the release of active compounds, bioactive functionalized surfaces can exert long-lasting antimicrobial effects through direct contact with microorganisms while minimizing the development of antimicrobial resistance. Furthermore, these functionalized surfaces promote improved tissue compatibility, reduce inflammatory responses, and support wound healing, making them particularly valuable for surgical barrier films, implant coatings, and advanced wound-care applications. Ongoing research focuses on improving the stability, durability, and controlled functionality of bioactive coatings to maximize their clinical effectiveness and long-term infection prevention performance.

MANUFACTURING TECHNOLOGIES FOR POLYMER-BASED BARRIER FILMS

With new forms of production, we can produce movies with precise micro-structures and designed qualities that meet the effects of surgery.

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Extrusion and Coextrusion

Barrier films are still predominantly prepared by extrusion. Co-extrusion is a method where we put several polymers in a single film of the multilayer that creates both rigory and water resistance. The importance of these co-extruded films is in the advanced surgical wrapping and exceptionally robust dresses [28].

Solvent Casting and Spin Coating

Solvents casting and spin coating enable us to control the depth to a dot when we require a very pure film or need to incorporate nanocomposites. These methods are suitable in developing movies containing nanoparticles or responsive chemicals [29].

Electrospinning

Electrospinning is a technology that enables the development of ultra-thin fibers, which constitute a network of tiny holes. It is employed in the form of breathable gowns, air filters and wound-contact layers that use that network. Electro spun films can also be bonded on conventional polymer sheets and this provides us with strength and a great filtration [30].

Additive Manufacturing and Digital Fabrication

New 3D and 4D printing can print in any custom shape of the films and that can evolve through time. Digital dispensing can produce gradients – dissimilar properties throughout the movie – in this way we can design sterility solutions tailored to particular surgical requirements [31].

Layer-by-Layer Assembly and Surface Coating Technologies

Layer-by-layer (Lb) assembly and advanced surface coating technologies have emerged as promising manufacturing approaches for fabricating multifunctional polymer-based barrier films with precisely controlled architectures. The Lb technique involves the sequential deposition of oppositely charged polymers, nanoparticles, or bioactive molecules to produce ultrathin multilayer coatings with excellent uniformity and tenable thickness [32]. This approach enables the incorporation of antimicrobial agents, growth factors, enzymes, and stimuli-responsive materials while maintaining the mechanical integrity and flexibility of the underlying polymer film. In addition, coating techniques – such as dip coating, spray coating, plasma-assisted deposition, and chemical vapor deposition – are widely employed to improve surface hydrophobicity, antimicrobial performance, chemical resistance, and durability. These manufacturing technologies facilitate the development of high-performance surgical barrier films with enhanced infection-control capabilities, prolonged service life, and improved compatibility with sterilization processes. Continued advancements in automated coating systems and scalable manufacturing methods are expected to support the large-scale production of next-generation polymer barrier films for diverse clinical applications.

APPLICATIONS IN SURGICAL ENVIRONMENTS

Infection control is enhanced by specifically designed polymer barrier films applied into many surgical parts.

Surgical Drapes

Current drapes are made from multilayered polyethylene (PE) or polyurethane (PU) films and they may contain absorbent non-wovens. Antimicrobial and super-hydrophobic layers prevent passage of liquids through and prevent proliferation of bacteria near the incision.

Instrument Covers and Sterile Packaging

PET and co-extruded films are used to protect products throughout sterilization and surgery. They remain clean so that clinicians can watch equipment, but they maintain cleanliness. Thermo-formable films can be shaped on precise subjects of complex tools [33].

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Wound Protectors and Barrier Devices

Polymer wound dressing maintains open surgeries clean. PU or silicone films stuck around tissue decreasing surgical site infection (SSI) risks. When nanocomposites are utilized in such films, they are even more effective regarding prevenance against microbes. Engineering Strategies of polymer-based barrier film in infection control of surgical environment. These strategies are presented in Table 1.

Table 1. Polymer-based barrier film engineering strategies for infection control in surgical environments.

Engineering aspect	Materials/approaches discussed	Key functional properties	Infection-control benefit	Typical surgical applications
Base Polymer Classes	Polyolefins (PE, PP), Polyurethanes (PU), Polyesters (PET), Silicones, Bio-based polymers (PLA, PHA, cellulose derivatives)	Mechanical durability, low porosity, chemical resistance, sterilization stability	Prevents microbial and fluid penetration	Drapes, gowns, instrument covers, sterile packaging.
Nanocomposite Reinforcement	AgNPs, ZnO, TiO_2, silica, layered silicates, graphene oxide	Enhanced strength, antimicrobial activity, tortuous diffusion pathways	Reduced bacterial adhesion and replication	Wound barriers, PPE films, antimicrobial drapes.
Nanofiber-Hybrid Films	Electrospun polymer nanofibers integrated with dense films	High surface area, breathability, filtration efficiency	Improved air/fluid filtration with comfort	Surgical masks, gowns, air-barrier layers.
Surface Engineering Strategies	Hydrophobic/superhydrophobic coatings, zwitterionic brushes, antimicrobial agents	Low surface energy, biofilm resistance, contact-killing or release-based antimicrobial action	Minimizes contamination and biofilm formation	Drapes, wound protectors, reusable covers.
Stimuli-Responsive (Smart) Films	pH-, temperature-, or light-responsive polymers	Controlled permeability, on-demand antimicrobial release	Targeted infection control with reduced toxicity	Advanced wound barriers, long-duration surgeries.
Manufacturing Technologies	Extrusion/coextrusion, solvent casting, electrospinning, additive manufacturing	Multilayer structures, controlled thickness, gradient properties	Reliable, scalable production of high-performance films	All surgical barrier products.

Personal Protective Equipment (PPE)

Face shield and gowns have engineered layers of film integrated on masks. Nanofiber layers are good filters that remain air permeable. Antimicrobial coating removes the number of germs in the surface of the surface during extended operations [34].

PERFORMANCE EVALUATION AND REGULATORY CONSIDERATIONS

Barrier films must meet the world standards of sterility, strength, and safety. Efforts – such as standards such as ISO 17025, ISO 10993 and FDA device regulations – provide testing directions. We determine stretch resistance, pressure resistance, bacteria-filtering (BFE) quality, virus penetrated the cell, and cell toxicity. Before clinical use, it is a requirement to meet these standards.

CHALLENGES AND FUTURE DIRECTIONS

Polymer barrier films can be associated with numerous benefits, yet some challenges are still posed. The most critical concern is the sustainability owing to the fact that most of the films are disposable. The biodegradable polymers are potentially good, only that they should have an enhanced ability to take heat and withstand sterilizing. We should also afford to weigh strong antimicrobials against the safety of the user in the long run. An excessive level of release of metal ions or chemicals may be damaging to the cells.

Additional efforts to develop surgical-sensing multi-functional movies that can degrade better and adjust to surgical conditions are bound to be done in the future. Machine-learning design and simulation

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processes will accelerate our process of refining the film characteristics. Continuing clinical tests is essential to ensure that these films with high-level sophistication actually assist in preventing infections.

CONCLUSION

The production of polymer barriers films has become amongst the strategies of enhancing infection control in modern operating theatres. Unexpected polymer science, nano compositions, and surface modifications help us to make films that are more tough, kill more microbes and change their environment. These films play an important role in packaging, PPE, wound covers, and surgical drapes to ensure patient and clinician safety. However, sustainability, long-term safety, and the proper ratio of antimicrobial power remain to be addressed. Concepts such plant based polylactic polymers, intelligent responsive systems, and multi-functional nanocomposites are promising but they must be put on clinical trial and their regulators must be resolved. Since the increasingly complex operations and stricter infection regulations give rise to new functions of polymer barriers, they will continue to fill the functions of modern health care requirements. It will be necessary to have the collaboration of scientists, doctors, and regulators to transform these ideas into reliable solutions that enhance the safety and sustainability of surgery.

REFERENCES

1. Fan J, Abedi-Dorcheh K, Sadat Vaziri A, Kazemi-Aghdam F, Rafiya S, Sohrabinejad M, et al. A review of recent advances in natural polymer-based scaffolds for musculoskeletal tissue engineering. Polymers (Basel). 2022;14(10):2097.
2. Naseem M, Islam MU, Kareem A, Sultan M, Khan I, Ahmad S, et al. Chitosan as a nanocomposite matrix: Advances in nanostructure fabrication, functional properties, and multidisciplinary applications. J Mater Sci. 2025;60(25):10225–54.
3. Jamwal V, Mittal A. Recent progresses in nanocomposite films for food-packaging applications: Synthesis strategies, technological advancements, potential risks and challenges. Food Rev Int. 2024;40(10):3634–65.
4. Atik R, Islam R, Ariza Gonzalez M, Chinwangso P, Lee TR. Recent advances in polymer-coated metal and metal oxide nanoparticles: From design to promising applications. Nanomaterials (Basel). 2025;15(22):1744.
5. Butler J, Handy RD, Upton M, Besinis A. Review of antimicrobial nanocoatings in medicine and dentistry: Mechanisms of action, biocompatibility performance, safety, and benefits compared to antibiotics. ACS Nano. 2023;17(8):7064–92.
6. Dehghani S, Rezaei K, Hamishehkar H, Oromiehie A. Investigating the physical, barrier, biodegradable and antimicrobial characteristics of composite and bilayer films containing chitosan electrospun nanofibers. Int J Biol Macromol. 2025;330(Pt 4):148145. doi: 10.1016/j.ijbiomac.2025.148145.
7. Adetunji AI, Erasmus M. Green synthesis of bioplastics from microalgae: A state-of-the-art review. Polymers (Basel). 2024;16(10):1322.
8. Han J, Poma A. Molecular targets for antibody-based anti-biofilm therapy in infective endocarditis. Polymers (Basel). 2022;14(15):3198.
9. Bayer IS. Biopolymers in multilayer films for long-lasting protective food packaging: A Review. In: Athanassia A, editor. Sustainable Food Packaging Technology. Weinheim: Wiley-VCH; 2021. p. 395–426. doi: 10.1002/9783527820078.ch15.
10. Kera NH, Pillai SK, Ray SS. Inorganic Ultraviolet Filters in Sunscreen Products: Status, Trends, and Challenges. Cham: Springer Nature Switzerland; 2024. doi: 10.1007/978-3-03164114-5.
11. Herczeg CK, Song J. Sterilization of polymeric implants: challenges and opportunities. ACS Appl Bio Mater. 2022;5(11):5077–88.
12. Stürzel M, Mihan S, Mülhaupt R. From multisite polymerization catalysis to sustainable materials and all-polyolefin composites. Chem Rev. 2016;116(3):1398–433.
13. Tolbert JW. Investigating and controlling the mechanical properties of solvent-cast constructs for tunable biomaterial scaffolds [dissertation]. Bethlehem (PA): Lehigh University; 2023.
14. Giri BR, Jakka D, Sandoval MA, Kulkarni VR, Bao Q. Advancements in ocular therapy: A review of emerging drug delivery approaches and pharmaceutical technologies. Pharmaceutics. 2024;16(10):1325.

© STM Journals 2026. All Rights Reserved

15. Zhang S, Fang H, Tian H. Recent advances in degradable biomedical polymers for prevention, diagnosis and treatment of diseases. Biomacromolecules. 2024;25(11):7015–57.
16. Frýdlová B, Fajstavr D, Kasálková NS, Rimpelová S, Pavlíčková VS, Švorčík V, et al. Replicated biopolymer pattern on PLLA-Ag basis with an excellent antibacterial response. Heliyon. 2023;9(11):e21566. doi: 10.1016/j.heliyon.2023.e21566.
17. Vasluianu RI, Bobu L, Lupu IC, Antohe M, Bulancea BP, Moldovanu A, et al. Innovative smart materials in restorative dentistry. J Funct Biomater. 2025;16(9):318.
18. Guo S, Chen J, Zhang Y, Liu J. Graphene-based films: Fabrication, interfacial modification, and applications. Nanomaterials (Basel). 2021;11(10):2539.
19. Fu J, Liao X, Ji Y, Mo Y, Zhang J. Research progress on preparation of superhydrophobic surface and its application in the field of marine engineering. J Mar Sci Eng. 2024;12(10):1741.
20. Zhou Z, Wang Y, Liu N, Zhang X, Ning X, Miao Y, et al. Multifunctional nanofiber-based dressings in coordination with adipose-derived stem cells for accelerated burn wound healing. Mater Des. 2025;253:113929. doi: 10.1016/j.matdes.2025.113929.
21. Alzahrani AS, Alamry KA, Hussein MA. Advanced biopolymer nanocomposites for real-time biosurveillance and defense against antimicrobial resistance and viral threats. RSC Adv. 2025;15(39):32431–63.
22. Nicolae-Maranciuc A, Chicea D. Polymeric systems as hydrogels and membranes containing silver nanoparticles for biomedical and food applications: Recent approaches and perspectives. Gels. 2025;11(9):699.
23. Joseph B, Jose C, Kavil SV, Kalarikkal N, Thomas S. Solvent-casting approach for design of polymer scaffolds and their multifunctional applications. In: Mohan T, Kleinschek KS, editors. Functional Biomaterials: Design and Development for Biotechnology, Pharmacology, and Biomedicine. Weinheim: Wiley-VCH; 2023. p. 371–394. doi: 10.1002/9783527827657.ch12.
24. Wang Y, Lu S, Zheng J, Liang L. Advances in latest application status, challenges, and future development direction of electrospinning technology in the biomedical. J Nanomater. 2022;2022:3791908. doi: 10.1155/2022/3791908.
25. Lorenzett E, da Campo YA, Neto MA, Burgo TA. Direct observation of electrostatic charging in 3D printing. Nat Commun. 2025;16(1):7727.
26. Ghosh S, Dave V, Sharma P, Wal P. Advancement of nanomedical biotextiles for infection control and protection materials. In: Basak P, Das S, Manna S, Sinha S, editors. Nanotechnology Based Advanced Medical Textiles and Biotextiles for Healthcare. Boca Raton (FL): CRC Press; 2024. p. 123–147. doi: 10.1201/9781003331612-8.
27. Ashter SA. Applications of polymers and plastics in medical devices: Design, manufacture, and performance. Oxford: William Andrew; 2022. ISBN: 978-0-12-820980-6.
28. Kang SI, Oh HK, Kim MH, Kim MJ, Kim DW, Kim HJ, et al. Systematic review and meta-analysis of randomized controlled trials of the clinical effectiveness of impervious plastic wound protectors in reducing surgical site infections in patients undergoing abdominal surgery. Surgery. 2018;164(5):939–45.
29. Darie-Niță RN, Râpă M, Frąckowiak S. Special features of polyester-based materials for medical applications. Polymers (Basel). 2022;14(5):951.
30. Yue X, Zhong Z, Wang C, Zhao Z, Zhang X, Wang G, et al. Antimicrobial peptide dendrimers assisted nanocomposite-loaded lyotropic liquid crystalline for multimodal surgical site infection management. Chem Eng J. 2024;479:147812. doi: 10.1016/j.cej.2023.147812.
31. Santos JF, del Rocío Silva-Calpa L, de Souza FG, Pal K. Central countries' and Brazil's contributions to nanotechnology. Curr Nanomater. 2024;9(2):109–47.
32. Saravanan H, Subramani T, Rajaramon S, David H, Sajeevan A, Sujith S, et al. Exploring nanocomposites for controlling infectious microorganisms: Charting the path forward in antimicrobial strategies. Front Pharmacol. 2023;14:1282073. doi: 10.3389/fphar.2023.1282073.
33. Zhang J, Jiang X, Wen X, Xu Q, Zeng H, Zhao Y, et al. Bio-responsive smart polymers and biomedical applications. J Phys Mater. 2019;2(3):032004.
34. Gautam S, Yi DK, editors. Advanced synthesis and medical applications of calcium phosphates. J Biomed Mater Res A. 2022;110(3):708–24.

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