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Editorial: Advanced fiber materials for controlled release, tissue repair, and regenerative medicine

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Editorial on the Research Topic
Advanced fiber materials for controlled release, tissue repair, and regenerative medicine

Advanced fiber materials are a new generation of fibers that can be mass-produced and hold specific properties and applicability for use in a rich variety of applications. From natural fibers such as cotton, hemp, silk, and wool, which are commonly used in daily life, to high-performance synthetic fibers that can be used in transportation, environmental safety and protection, medical and health care, aerospace, national defense and military industry, fiber materials are closely related to the development of human society. In particular, advanced fiber materials can have good biocompatibility, low immunogenicity, mimic the properties of the extracellular matrix, and encapsulate a variety of functional molecules such as drugs and biological factors. This allows them to play important roles in controlled release, tissue repair, and regenerative medicine.

Research in advanced fiber materials currently often takes the direction of making intelligent systems, functionalization, and greening. This relies deeply on the cross-fertilization of disciplines such as material science, chemistry, biomedical engineering, biomedicine, Advanced fiber materials have played an irreplaceable role in the biomedical field, such as for surgical dressings, artificial organs, repair materials, diagnostic and therapeutic instruments (Liu et al, 2023). Despite the remarkable progress of advanced fibrous materials in tissue repair and regeneration, many questions remain to be addressed in this research area. Herein, this special issue contains five publications, focusing on the design, preparation, and optimization of advanced fiber materials for manipulating cell behavior, controlled release, and tissue repair (Ghorghi et al, 2020; Wang et al.; Zhou et al.; Gizaw et al.; Li et al.). Researchers from China, U.S., and Saudi Arabia contributed to these studies. Li et al. reviewed the sources and characteristics of biomass-derived fibers (i.e., polysaccharide fibers and protein fibers) that are commonly used in medical field (Li et al.). In particular, cellulose, chitin, alginate, silk fibroin, collagen, and hyaluronic acid have been widely used as antibacterial skin-wound dressings, tissue-engineered scaffolds, and carriers for drug delivery. 3D printed biomass-derived fiber materials have also been demonstrated the promising potential for use in biomedicine. Gizaw et al. reported the fabrication of drug-eluting microfibers made of a blend of polycaprolactone (PCL) and chitosan for topical drug delivery. The electro spinning technique has been used to fabricate these PCL/chitosan fibers, and acetylsalicylic acid, a model small molecule drug, was selected to test the release profile. The fibers showed a burst profile of the payloads (30%) up to 2 h followed by a zero-order release profile up to 2 days. Such fiber materials were designed for use in the repair of chronic and non-healing wounds.

Fiber materials can also be integrated with other classes of materials (e.g., hydrogels and nano-structured materials) to obtain antibacterial or anticancer properties, systems capable of diagnosis, and those able to modulate the tissue microenvironment. For example, the hyaline cartilage is rich in glycosaminoglycan's and highly-adherent collagen fibers (Wang et al.). To repair the cartilage defects, Wang et al. reviewed the progress of self-assembling peptide Nano fiber hydrogels. As a typical example, aromatic short peptides showed Nano fiber structures like natural collagen fibers. These peptides can serve as carriers to transport cells and construct scaffolds that simulate the natural extracellular matrix for cartilage tissue engineering. Electro spun fibers can also be fabricated by encapsulating drugs and nano-structured materials such as carbon quantum dots for manipulating cell behaviors (Ghorghi et al, 2020). For example, composites made of hydroxyapatite, collagen, and carboxylic carbon quantum dots have been fabricated to load chrysie for promoting the proliferation and differentiation of bone marrow mesenchyme stem cells (Zhou et al.). Such scaffolds are suitable for use in bone regeneration applications. Another importance class of functional nanomaterial's are exosomal-based materials, which shows potential use in the delivery of drugs and/or genes, tumor targeting, and disease treatment (Chen et al.). How to effectively integrate exospores with fiber materials is an emerging challenge in the field of tissue repair and regeneration.

There are a number of advantages in using advanced fiber materials for controlled release, tissue repair, and regenerative medicine. Firstly, the fiber materials can replicate the Nano scale dimension and composition of the native cellular matrix, which will contribute to the manipulation of cell behavior and tissue regeneration. In addition, a rich variety of structural modification can be made on the fiber surfaces, such as the addition of pores, protrusions, grooves, nano/micro particles, etc. Last but not least, biological and/or chemical signals can be integrated with the fiber materials either during the manufacture process or by post-treatment. Thus, we believe this section will give valuable information for the design of fiber materials and their possible applications in biomedicine. The application of these biomedical materials can also be extended to other related areas.

Author contributions

TW wrote the original manuscript. GW, YW, TZ, and BS revised the manuscript. All authors contributed to the article and approved the submitted version.

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