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Applications of Natural Polymer-Based Biomaterials

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INTRODUCTION

Hydrogels are three-dimensional (3D) polymeric structures that inflate when exposed to water, they are often employed in 3D and 4D printing as well as in biological applications such targeted drug delivery, tissue engineering, and smart biosensors. These applications include delicate elements like cells or need the use of intricate material forms. Macroscopic structuring, such as that provided by an auxetic structure, can provide a material an additional level of functionalization. When mechanical stress is applied, auxetic structures respond, for instance, by interacting spatially with a building in certain directions. The addition of an auxetic structure can enhance mechanical qualities including shear resistance, fracture toughness, and resilience in compared to unstructured structures made of the same material. In general, a supply of monomers can be physically or chemically crosslinked to create hydrogels. Unmodified proteins may be employed to create dityrosine-crosslinked hydrogels *via* enzymatically, fenton-like, or photoinitiated processes to crosslink phenolic hydroxy groups. Tris(2,2'-bipyridyl) dichlororuthenium(II) (Ru(bpy)3Cl2) is a popular photoinitiator for dityrosine crosslinking in the area of 3D printing. It is induced by visible light in the presence of an electron acceptor such ammonium or sodium persulfate. This method may be used to produce stimuli-responsive hydrogels. These hydrogels specifically alter their structure and volume phase transition in response to outside stimuli.

DESCRIPTION

Thickeners like the linear and highly charged polysaccharide sodium alginate are frequently employed to boost the structural integrity of ink formulations in order to improve the manufacturing window in extrusion 3D printing. Alginate is frequently used as an extrudable bioink hydrogel material because of its excellent biocompatibility and simplicity of handling. Ionic crosslinking causes sodium alginate to hydrogel when it is exposed to multivalent metal cations or acid solutions. So, it is possible to create a so-called double-network hydrogel by further crosslinking sodium alginate. Since water makes up a large portion of hydrogels, it is important to have a better knowledge of swelling level and mechanical stability. In contrast to soaked hydrogel samples, current methods for determining the degree of swelling and water absorption mostly rely on weight or volume measurement of dry or as prepared hydrogels. Thus, weight measurements are simple to carry out, albeit it is often difficult to estimate the volume of the complicated geometries. So, swelling ratios depending on weight are often published in the literature. These techniques, however, need the complete elimination of surplus liquids without pulling liquid from the hydrogel network, and do not offer insight into the time-dependent, spatially resolved hydration of the interior hydrogel structure. In order to create new materials, it is desirable to have a portable, site-resolving, non-destructive 3D analytical approach. A 3D imaging method called Magnetic Resonance Imaging (MRI) is employed in the study of food, material sciences, and medical diagnosis. Thus, the NMR relaxation characteristics and variations in spin density inside a material are frequently dependent on the image contrast. It has recently been demonstrated that it can be used to investigate many popular bioink materials as well as complicated 3D things created by 3D printing. The primary benefit of MRI, putting aside its high initial costs and operational complexity, is its independence from the substance being investigated and from optical transparency, allowing volumetric temporal and spatially resolved longitudinal investigations on the same item. Elastin differs from other natural structural proteins in that it has special qualities that have been used over time to create new biomaterials for a variety of uses. In fact, elastin is a naturally occurring

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fibrous protein that is found in the extracellular matrix of higher vertebrates, particularly in organs and connective tissues that need to stretch or contract repeatedly and reversibly (such as the skin, tendons, aorta, lungs, and elastic ligaments). Elastin gives these tissues their elasticity and resilience. Due to its high concentration of hydrophobic amino acids and the high number of interchain crosslinks involving oxidised lysine residues, elastin is a very insoluble and resistant to degradation protein. After being enzymatically modified and aggregated from its soluble monomeric precursor, tropoelastin (70 kDa), which is produced and secreted by a variety of cells including smooth muscle cells, endothelial cells, fibroblasts, and chondrocytes, elastin fibres are formed extracellularly around a fibrillin-rich microfibrillar structure. In the past two decades, materials scientists have drawn inspiration from the structure and mechanical characteristics of elastin, particularly for biomedical applications. In this review paper, we first briefly reviewed the ground-breaking contributions that helped elastin-like polypeptides become a distinct field of study (ELPs). In the second section, we've emphasised the significant advancements made in the genetic engineering and bacterial production of ELPs, which have unquestionably made it possible to examine these recombinant polypeptides seriously for the creation of biomaterials.

CONCLUSION

In the primary and concluding portion of this review paper, we discussed the topic of ELP-polymer conjugates and focused on the inventive ways in which ELPs have been integrated into block, graft, and statistical copolymer designs. Finally, we provide the readers our own take on the subject and many potential vantage points in the conclusion section. The varieties of physicochemical and biological characteristics of the polymeric substrates have a significant impact on the qualities of the resulting material, regardless of the kind of material generated. For instance, the addition of LNFs to a pullulan matrix not only improved the mechanical characteristics of the transparent pullulan films (Young's Modulus and elongation at break), but also resulted in the introduction of novel functionalities, notably antioxidant. Designing materials with these qualities can also benefit from the usage of bioactive chemicals and substances. For instance, ellagic acid, a naturally occurring polyphenolic molecule, can be combined with chitosan to give chitosan films antioxidant and UV-barrier qualities. Another instructive example is the chemical modification of chitosan to produce transparent films with fluorescent qualities for the purpose of (bio)imaging and (bio)sensing, by chemically grafting corrole macrocycles (such as 5,10,15-tris(pentafluorophenyl)corrol, TPFC).