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File name:	ions_as_Adhesives_Photocatalysts_and_Electroactive_Materia...
File size:	8.94M
Page count:	131
Word count:	35,181
Character count:	194,477
Submission date:	06-Jan-2025 11:16AM (UTC+0530)
Submission ID:	2560132175

A general introduction to hydrogel, its properties and applications in various fields Chapter 1

1.1 Introduction

Ever since the discovery of polymeric materials, their application has been gradually increasing and within no time it has become an inescapable part of modern society. Researchers worldwide have been working on advanced functional polymers because of their fast-growing demands in life-changing technologies. One such polymeric material is "hydrogel", considered one of the most versatile biomaterials in material chemistry. Polymeric hydrogel is a soft and wet material saturated with water and is sometimes called 'aqua gel' [1]. It is broadly defined as a three-dimensional (3D) network of polymeric compounds crosslinked together by different monomeric units. For the last many years, the exploitation of hydrogel in our daily lives has reached a great height. The porous structure and hydrophilicity of the hydrogel allow them to absorb large amounts of water. The hydrophilicity of the hydrogel is mainly due to the presence of hydrophilic functional groups such as hydroxyl groups, carboxylic groups, amine, and sulfate groups [2-5]. This water sorption can be attributed to the capillary, osmotic, and hydration forces. On absorbing water, the hydrogel undergoes swelling and absorbs water or other aqueous solutions several times its dry weight without dissolution. The hydrogel can undergo reversible swelling and deswelling and retain a huge amount of water for a long period [6]. The swelling property of the hydrogel depends on the type of monomers used, swelling media, and crosslinking within the hydrogel. The structural integrity of the swollen hydrogel remains intact due to the crosslinking within the polymeric structure [7]. The crosslinking within the hydrogel can be chemical, physical, or a combination of both, and by controlling the crosslinking density, various physical and chemical properties of hydrogel can be tuned. Again, hydrogels can absorb water, biological fluids, and various electrolytic solutions, enabling their feasible application in biomedicine, bioelectronics, sensing, etc. The high-water content in the hydrogel imparts exceptional qualities such as softness and flexibility into the hydrogel matrix. The combination of these properties and high porosity renders hydrogel to mimic natural tissue and has found numerous applications in biomedical areas more often than any other biomaterial [8]. These hydrogels have been synthesized by incorporating specific functionalities into the conventional polymer material [9]. The cost-effective and versatile nature of multifunctional hydrogel leads to their application in almost every field such as in

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Exploration of Polymeric Hydrogels: Potential Applications as Adhesives, Photocatalysts, and Electroactive Materials

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File name: ions_as_Adhesives_Photocatalysts_and_Electroactive_Materials.pdf (8.94M)
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