

Scotland's Rural College

## Preface

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# Preface

Engineering of complex tissue construction is a major challenge to mimic or encourage native-like tissue microenvironment for progressive cellular fate while treating organ grievances, aging, and diseases. To achieve the native tissue-like characteristics, in the past decades, various superior biomaterials have been developed to control the functional characteristics of engineered constructs. Among them, hydrogels are having the great potential to have most similar characteristics to native tissue due to their tunable and biochemical properties. Hydrogels are intensely hydrophilic and three-dimensional (3D) dynamic polymeric network assemblies that have been broadly investigated and utilized in diverse biomedical areas, including tissue engineering, wound healing, drug delivery, cancer theranostics, biosensing, and antimicrobial/antibacterial applications. However, their broad utilization in the abovementioned areas has been limited due to their poor mechanical characteristics and inadequate functions related to the targeted applications. Because of these challenges, several nanostructures (e.g., carbon-based, ceramic and/or metallic, and polymeric nanomaterials) have been integrated into hydrogel networks to improve their functionalities synergistically as innovative biomaterials emerging for biomedical applications. These designed functional nanocomposite hydrogels exhibit remarkable physicochemical and biological characteristics. The ongoing progress in design concepts and development of nanocomposite hydrogels with tailored functionalities has initiated innovative prospects to synthesize unique biomaterials for diverse biomedical applications. However, there are still various challenges to be overcome in manufacturing sophisticated functional nanocomposite hydrogels.

This book focusses on the recent and the collective research developments in the multifunctional nanocomposite hydrogels, including their characteristics, types, manufacturing methods, characterization, and their applications in diverse biomedical and biotechnological areas by using different nanomaterials. The main purpose of this book is to provide information on a broad range of hydrogel structures, design approaches, processing, characteristics, and their particular use in different biomedical areas, including tissue engineering, drug delivery carriers and theranostics, and additive manufacturing. On this matter, first, the fundamentals of hydrogels and nanocomposite hydrogels are presented in terms of structural characteristics, properties, and their characterization. Then, individual chapters focus on the nanocomposite hydrogels based on cellulose for wound management, alginate for antimicrobial and antibiofilm applications, collagen for bone tissue engineering, protein, bisphosphonate, graphene oxide for biosensor, graphene quantum dots for anticancer drug delivery, and hydroxyapatite for bone tissue

regeneration. Some specific mechanisms of actions in nanocomposite hydrogels are reviewed and discussed through dual-crosslinked for antibacterial applications, conductive adhesive self-healing for photothermal therapy in wound healing, thermoresponsive for localized cancer theranostics, and nanogels for loco-regional drug delivery. Furthermore, other functionalized nanocomposite hydrogels based on nanobioglass, polyhedral oligomeric silsesquioxane, periodic mesoporous organosilica, silver nanoparticles, lignin, chitosan, starch, environmental sensitivity, or 3D printing are discussed for miscellaneous biomedical applications. Moreover, the key challenges and future prospects associated with the design, manufacturing, and characterization of functional nanocomposite hydrogels are also discussed in each chapter. Therefore an updated collection of various functional nanocomposite hydrogels will be useful reference text for undergraduate/postgraduate students and essential reading for professors, scientists, engineers, and clinicians working on hydrogel biomaterials in diverse biomedical areas.

At last, but most notably, we would like to thank and acknowledge the authors who contributed to this book. Furthermore, we thank all the reviewers for giving their valuable time and providing timely constructive comments and suggestions to improve the quality of this book.

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