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Editorial

Special Issue: Nanocomposite Hydrogels for Biomedical Applications

Kazuaki Matsumura

School of Materials Science, Japan Advanced Institute of Science and Technology, 1-1, Asahidai, Nomi, Ishikawa 923-1292, Japan; mkazuaki@jaist.ac.jp

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A hydrogel consists of a three-dimensional network of polymer chains, with water as a solvent in the system. Since the study by Wichterle and Lim on poly (2-hydroxyethyl methacrylate) hydrogels [1], these materials have been widely studied in the fields of tissue engineering, drug delivery systems (DDSs), artificial organs, and implantable materials [2] due to their high biocompatibility and high water content, which are similar to human body tissue. Biodegradable hydrogels are used for constructing cell scaffolds in tissue engineering, regenerative medicine, and DDS. Naturally derived, polymer-based hydrogels that are biodegradable and exhibit low toxicity can be used not only in tissue engineering but also as DDS carriers. Polysaccharide hydrogels are one of the most widely used polymeric systems and can be easily modified using their hydroxyl groups. In tissue engineering, alginate, dextran, chitosan, and polypeptide hydrogels have been studied to regenerate bone and skin tissues [3,4] and develop anticancer drugs, antimicrobial drugs, growth factors, and protein delivery systems [5,6]. Additionally, synthetic polymer-derived hydrogels have biomedical applications because it is easy to control the characters of hydrogels. For example, polyethylene glycol hydrogels have been used for cell culture scaffolds owing to the introduction of enzymatically degradable moieties [7].

Nanocomposite polymer hydrogels are defined as cross-linked polymer networks swollen with water in the presence of nanoparticles and nanostructures. The goal of this special issue is to showcase some of the most recent studies and developments in the biomedical applications of nanocomposite hydrogels. Nanoparticles and nanostructures are added to cross-link the polymer network and add new properties to hydrogels [8]. Clay has been introduced into a polymeric solution system for cross-linking through non-covalent physical interactions between clay and the polymer chain to form flexible hydrogels [9] to be applied in an actuator. The cross-linked polymer networks are capable of reversible volume change in response to external stimuli. Magnetic nanoparticles incorporated in thermo-responsive polymer hydrogels show magneto–thermo stimuli-responsive properties for cell regulation [10]. Furthermore, when used as a biosensor, the distribution of gold nanoparticles in hydrogels influences the nanoplasmonic response. Therefore, a new strategy has been developed for nanoparticle mapping in hydrogels using electron microscopy [11].

For drug delivery, protein-releasing hydrogels are widely used. DNA is a polymer material required for hydrogel formation. Du reported that aptamer-functionalized DNA hydrogels can serve as an appropriate candidate for controlled protein delivery by controlling complementary sequences as a biomolecular trigger [12].

For soft tissue replacement, hydrogels are a suitable choice. Polyvinyl alcohol (PVA) has been extensively studied as an articular cartilage material [13,14]. PVA solution forms a hydrogel because the hydrogen bonding between hydroxyl groups in the polymer chain become cross-linking points. A PVA hydrogel has high biocompatibility, stability, and wear-resistance. Additionally, graphene-oxide (GO) added to PVA hydrogel enhances not only the resistance but also the cytocompatibility of PVA hydrogels and shows strong adhesion to bone and cartilage [15].

Two review papers regarding polysaccharide hydrogels are included in this special issue. These investigate DDS using mucoadhesive hydrogels [16] and chitosan hydrogels [17]. Polysaccharides have unique properties, such as degradability, high viscosity, tissue adhesion, antimicrobial activity, and cytocompatibility. In these reviews, the authors summarize that hydrogels with these functionalities of polysaccharides may solve the various current problems regarding the clinical application of hydrogels.

In conclusion, this Special Issue, with six articles from across this field, is a very limited sample of the available research to demonstrate the potential impact of nanocomposite hydrogels. I hope for more innovation in nanocomposite hydrogel technology in the future and for these hydrogels to be applied in various biomedical engineering fields.

Conflicts of Interest: The author declares no conflict of interest.

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