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Plasma-assisted Synthesis of Chitosan-Acrylic Acid Hydrogels

Kathrina Lois M. Taaca
[1] Department of Mining, Metallurgical, and Materials Engineering, College of Engineering, University of the Philippines Diliman, Philippines
e-mail (speaker): kmtaaca@up.edu.ph

Hydrogels are among the early polymeric biomaterials designed for use in humans. It has been an ideal candidate for biomedical applications due to its functional similarities to the natural extracellular matrix (ECM). Hydrogel preparation often considers the conventional route of utilizing chemical agents for the initiation and crosslinking stage of polymerization.

Recently, the use of atmospheric pressure plasma to facilitate hydrogel synthesis has been explored. The rich environment of radical species, generated upon plasma exposure of polymers in the liquid phase, may act as an initiator or crosslinker during the polymerization process in hydrogel synthesis. Figure 1 shows plasma acting as either initiation or crosslinking of polymeric solutions.

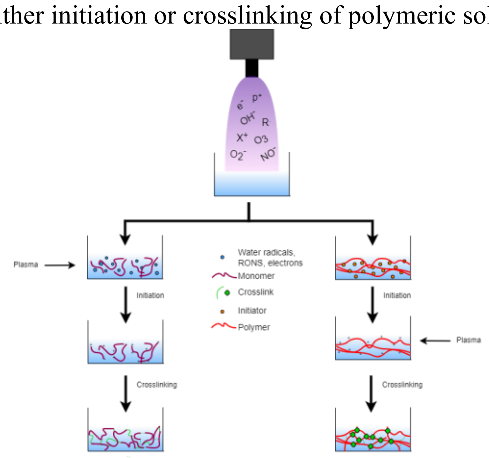

Figure 1. Plasma-assisted initiation and crosslinking of polymeric solutions. [1]

Given that the plasma-liquid interaction is considered a complex reaction mechanism, the feasibility of polymerization in the liquid phase was still pushed through. This study investigates the influence of atmospheric pressure plasma in modifying hybrid blends to form hydrogels. Chitosan and acrylic acid were selected as precursors of the hybrid blend to be used in developing hydrogels. The network formation of the chitosan-acrylic acid hydrogel, elucidated through near-edge X-ray absorption fine spectroscopy (NEXAFS), suggests that the structure was built by a combination of covalent and ionic amide linkages. Plasma-initiated polymerization of chitosan-acrylic acid complexes also led to the development of hydrogels that are porous, permeable, and have pH-responsive swelling behavior. Figure 2 and 3 shows the swelling capacity of the plasma-assisted chitosan-acrylic acid hydrogel. Plasma-assisted chitosan-acrylic acid hydrogel showed higher capacity when immersed in a simulated gastric fluid with pH of 1.2. The results of the study further suggest the feasibility of using plasma-assisted hydrogels as wound dressings.

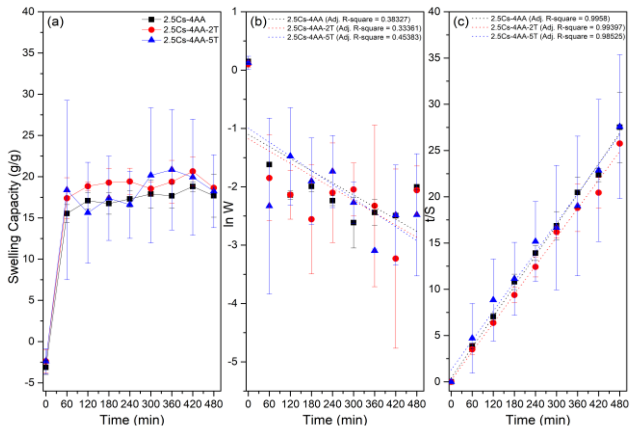

Figure 2. Swelling and kinetics analysis of plasma-assisted chitosan-acrylic acid hydrogels immersed in water.

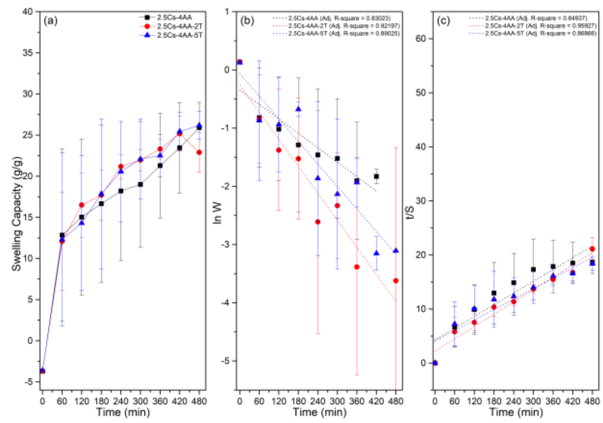

Figure 3. Swelling and kinetics analysis of plasma-assisted chitosan-acrylic acid hydrogels immersed in simulated gastric fluid (pH 1.2).

References

[1] Taaca, K.L.M.; Prieto, E.I.; Vasquez, M.R., Jr. Current Trends in Biomedical Hydrogels: From Traditional Crosslinking to Plasma-Assisted Synthesis. Polymers 2022, 14, 2560. https://doi.org/10.3390/polym14132560