Crosslinked Possibilities: The Expanding World of Poly(2-isopropenyl-2-oxazoline)-Based Hydrogels

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Soft materials are ubiquitous in our daily life and are key players in many industries, such as electronics, automobiles, environment, and robot engineering. Hard and heavy materials used 50 years ago have been replaced by soft and light materials such as polymers, liquid crystals, gels or colloids. Moreover, a high percentage of our body is made of soft materials having complex structural and dynamic properties. Thus, much scientific effort has been devoted to developing highly functional soft materials. Among soft materials, hydrogels are a promising material platform, especially in view of their biomedical applications such as drug delivery, tissue engineering, ocular devices, and tissue and organ replacement. [1] Hydrogels can be synthesized from both natural and synthetic polymers via physical or chemical crosslinking, offering a broad design space. While a multitude of synthetic hydrogel materials strategies have been reported, they all come hand in hand with shortcomings that can limit their applicability. [2]

The rising interest in smart and adaptable materials has prompted extensive exploration of new polymer systems capable of enabling the design of advanced hydrogels. A major focus in this pursuit is the discovery of polymers that offer flexible functionalization, reliable crosslinking options, and tunable degradability, features that conventional hydrogel precursors often lack or possess only to a limited degree.

In this respect, poly(2-isopropenyl-2-oxazoline) (PiPOx), has attracted increased scientific attention as a reactive polymer for the synthesis of advanced functional materials. [3] PiPOx is a versatile polymer soluble in water and various organic solvents, can be prepared with well-defined characteristics, and exhibits high thermal and good hydrolytic stability. [4] Furthermore, PiPOx was shown to be biocompatible, rendering it suitable for medical and pharmaceutical applications. [5,6] The pendent 2-oxazoline group can be transformed in an efficient, mild, and selective manner, providing an extremely valuable toolbox for the synthesis of advanced materials. The post-polymerization modification reaction with (di)carboxylic acids enabled access to a wide variety of structures with defined and controlled properties. The versatility of this modification method allows the synthesis of a wide variety of functional polymers with tunable properties from soft to hard materials. [7-9]

Recent developments from our research group that illustrate the potential of PiPOx as smart (bio)materials will be discussed in this lecture, ranging from fundamental studies on ring opening addition of PiPOx with carboxylic acids to emerging applications of these polymers as biomaterials, nanosensors, and drug delivery vehicles.

References

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