Designer Monomer Library for Enriching Polyether Chemistry Toward Biological Applications

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Poly(ethylene glycol) (PEG) is by far the most well-known synthetic biocompatible polyether for its widespread use in the food, cosmetics, and biomedical applications. However, its limited functionality combined with its complicated synthetic nature often poses challenges for advanced material design and synthesis. In this talk, our recent effort in the development of novel functional epoxide monomers with multifunctionality will be presented. Specifically, we cover the design and the synthesis of well-defined stimuli-responsive polyethers such as pH and redox for biocompatible and biodegradable smart drug delivery systems.

In the first part of the talk, the design and the synthesis of novel hydrophobic, pH-responsive epoxide monomer, tetrahydropyranyl glycidyl ether (TGE) will be discussed. Anionic ring-opening polymerization affords the controlled synthesis of a series of its homopolymers (PTGE) and amphiphilic polymers, poly(ethylene glycol)-*block*-poly(tetrahydropyranyl glycidyl ether) (PEG-*b*-PTGE). Interestingly, these block copolymers with cyclic TGE moieties showed superior stability in biological media, high loading capacity, tunable release, and controllable degradation compared to its acyclic analogue, 1-ethoxy glycidyl ether (EEGE), widely employed in the polyether, which satisfy all the required design principles and address the challenges in drug delivery systems.

In the second part of the talk, the redox-degradable hyperbranched polyglycerols (PSSG) based on a glycerol monomer containing a disulfide bond, i.e., 2-((2-(oxiran-2-ylmethoxy)ethyl)disulfanyl)ethan-1-ol (SSG) will be presented. The polymerization through anionic ring-opening multibranching polymerization to yield a series of redox-degradable hyperbranched polyglycerols (PSSGs) with controlled molecular weights and relatively low molecular weight distributions. Furthermore, the redox-responsive degradation of the polymers upon treatment with a reducing agent resulted in selective degradation of the polymers in small segments. With its high biocompatibility, we anticipate that these novel redox-degradable and will find applications in a variety of emerging biomedical fields.

Finally, other on-going researches in the group will be discussed in the context of complex macromolecular systems.