TECHNICAL INSIGHTS
FROST & SULLIVAN

HIGH-TECH MATERIALS ALERT

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NOVEL pH-RESPONSIVE GATING MEMBRANE SYSTEM

Environmental stimuli-responsive, controlled-release delivery systems have been developed with the aim of obtaining an improved drug treatment through rate- and time-programmed and site-specific drug delivery, because these delivery systems can release specified chemicals or drugs at a particular site where an environmental condition such as pH, temperature, or any other parameter is different from that at other sites. As it is known that the interstitial fluids of a number of tumors or inflamed sites in humans and animals have an ambient pH that is considerably lower than that of normal tissue, a pH-responsive, controlled-release delivery system enables drugs to target specific areas of the body including tumors, sites of inflammation and infection, or the colonic region. As for the environmental stimuli-responsive controlled-release systems, the fast response to environmental signals is very important to their successful application.

Several strategies have been explored to increase the response dynamics of stimuli-responsive polymeric hydrogels, which are the commonly used materials in fabricating the delivery systems. However, no research has focused on the improvement of the stimuli-responsive release rate, which is equally important to make the systems respond as quickly as possible upon receiving environmental signals.

Lately, a team of Chinese researchers, Liang-Yin Chu Group, from School of Chemical Engineering, Sichuan University, P. R. China, has reported a novel composite membrane system for pH-responsive controlled release featuring a fast response and a high responsive release rate, with the results appearing as one of the cover stories in the latest issue of the journal *Advanced Functional Materials* (vol. 16: pp. 1865). This system consists of a porous membrane with linear grafted, positively pH-responsive polymeric gates acting as functional valves, and a crosslinked negatively pH-responsive hydrogel inside the reservoir working as a functional pumping element. The pH-responsive gating membranes were prepared by grafting poly(methacrylic acid) (PMAA) linear chains onto porous polyvinylidene fluoride (PVDF) membrane substrates using a plasma-graft pore-filling polymerization, and the crosslinked poly(*N*,*N*-dimethylaminoethyl methacrylate) (PDM) hydrogels were

synthesized by free radical polymerization. The volume phase-transition characteristics of PMAA and PDM were opposite. The linear grafted gates led to a fast response, while the pumping effects of the hydrogel brought a high responsive release rate that goes effectively beyond the limit of concentration-driven diffusion.

This group has provided a new mode for pH-responsive "smart" or "intelligent" controlled-release systems with better performance than that of most existing systems. It has a patent on this work, which is available for licensing. According to Liang-Yin Chu, the new mode can be easily applied to microscale systems by introducing negatively responsive microgels or hydrogel nanoparticles into the inner space of porous microcapsules with functional gates, and this application will be the main task of their next plan. Additionally, the researchers are looking for collaborators to continue this work.

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