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Doo Sung Lee talks with *ScienceWatch.com* and answers a few questions about this month's Fast Moving Front Paper in the field of Materials Science.

Article: In situ gelling stimuli-sensitive block copolymer hydrogels for drug delivery
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Journal: J CONTROL RELEASE, 127 (3): 189-207 MAY 8 2008
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SW: Why do you think your paper is highly cited?

After biodegradable polyester-based *in situ* gelling thermosensitive hydrogels were first developed by Dr. Sung Wan Kim and his co-workers at the University of Utah about a decade ago, these novel intelligent materials have attracted worldwide interest and received intensive study for use in drug delivery.

In recent years, more and more interest has been focused on the development of novel systems capable of responding to multiple stimuli, especially to both pH and temperature. This paper is the first review on *in situ* gelling stimuli-sensitive hydrogels. Some of these concepts were formed on the basis of our research experiences in this field during a period of more than 10 years.

In this current paper, the recent development of *in situ* gelling stimuli-sensitive hydrogels was summarized based on their detailed molecular design, preparation, and drug delivery applications. A proper summary may also include some outline for the further development of this field.

SW: Does it describe a new discovery, methodology, or synthesis of knowledge?

To the best of our knowledge, this is the first review paper on the recent development of *in situ* gelling stimuli-sensitive hydrogels for drug delivery applications, even though there had been several review papers on the subject of thermosensitive hydrogels.

A new generation of injectable hydrogels, capable of responding to multiple stimuli, especially to both pH and temperature, has lots of advantages in practical applications and has therefore received increasing attention. In this paper, the recent development of injectable stimuli-sensitive hydrogels, including our own work, was first summarized, and the relationship between structure and function was thoroughly discussed.

"...these injectable stimuli-sensitive hydrogels may bring benefits to those *who are suffering from diabetes and other diseases and have potential social significance..."*

SW: Would you summarize the significance of your paper in layman's terms?

This paper summarized the recent development of injectable hydrogels from materials with an ability to respond to single stimulus to those capable of responding to multiple stimuli. These new materials possess many advantages when their use is applied within several complicated environments. The paper is also a summary of current achievements in the field and also outlines directions for further development.

SW: How did you become involved in this research and were any particular problems encountered along the way?

I joined the program on the development of the first generation of injectable and biodegradable thermogelling hydrogels as a member of Dr. Sung Wan Kim's group in 1997, and I've been developing new generations of *in situ* gelling stimuli-sensitive hydrogels for drug delivery since then.

We found some drawbacks for the first generation of materials and have tried to improve these materials by adjusting their topological structure, components, and molecular weight. Very recently, we developed pH- and temperature-sensitive injectable hydrogels, which show many advantages in various practical applications, including adjustable degradation behavior, and are easy to handle, displaying a sustained release profile along with an ability to maintain pH during their release, while also forming interactions with proteins and DNA.

SW: Where do you see your research leading in the future?

The main challenges for the applications of *in situ* gelling stimuli-sensitive hydrogels include short response time, proper gelation conditions, appropriate mechanical strength and persistence time, biocompatibility, and the likelihood to protect protein drugs in some adverse environments. This requires a system capable of responding to complicated changes of its environment. The pH- and temperature-sensitive hydrogels containing either polyanion or polycation developed in our lab quite recently, not only exhibit responses to multiple stimuli but also form interactions with ionic protein drugs and DNA. This new material is likely to find applications in the delivery of some protein drugs and genes.

SW: Do you foresee any social or political implications for your research?

Because of the sustained release character of these *in situ* gelling hydrogels systems, drugs incorporated within the hydrogels may remain effective in the body for a much longer period of time than those administrated through conventional methods, i.e., solution injection. For example, insulin-containing hydrogels may be administrated once every two weeks, compared to two injections per day by conventional methods.

Therefore, these injectable stimuli-sensitive hydrogels may bring benefits to those who are suffering from diabetes and other diseases and have potential social significance. Some conclusions in this paper may

be a useful reference for the further development of injectable hydrogels.

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