# SMART POLYMERS IN TEXTILE INDUSTRY

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***Abstract:*** *Smart polymers are polymers that respond with a considerable change in their properties to small changes in their environment. These undergo reversible large, physical or chemical changes in response to small external changes in the environmental conditions, such as temperature, pH, light, magnetic or electric field, ionic factors, biological molecules, etc. Researchers have made large number of attempts to synthesize smart materials by grafting the copolymerization of environmental-sensitive polymers onto the surface of different monomers. The natural polysaccharides have a different molecular structure and properties, but their common advantages such as renewable, biodegradable, nontoxic, biocompatibility, etc. make them found extensive applications as a commercial polymer in many areas. This article is summarized recent advances in the application of polysaccharides in different fields.*

## 1. Introduction

Recently, research has increased in the area of smart polymer/gels because they experience reversible phase transitions according to their surrounding environment conditions. These materials can be sensitive to the factors, such as temperature, pH, humidity, pressure, the intensity of light or an electrical or magnetic field (Yong and Park, 2001; Ozturk and Okay, 2002; Yildiz *et al.,* 2002). They respond in various ways, like altering their colour or transparency, becoming conductive or permeable to water, change in their swelling capacity, and change in adhesiveness or changing shape. These small changes in the environment are sufficient to induce greater impact on the polymer's properties. Many smart polymers have been reported so far and they have been utilized in the gel form for various scientific and technological applications fields. Smart polymers are particularly in agriculture and horticulture, sensors, biomedical and pharmaceutical applications such as controlled drug delivery. In order to improve the properties of natural polymers and to enhance their use-spectrum in textile industries and biomedical fields, in this article we reviewed modification of polymers by grafting of different monomers. Superabsorbent hydrogels formed by modified gum Arabic, polyacrylate and polyacrylamide used for the removal of dyes from textile wastewater (Saraydin *et al.,* 2001).

## 2. Methods of synthesis

Graft copolymerization is a generally used method for the modification of surfaces of polymeric materials and it is an important tool in order to modify the physical and chemical properties of polymers (Battaerd and Tregear, 1967; Dworjanyn et al., 1989; Khan, 2004). The active sites are generated on the polymeric back-bone for the synthesis of graft copolymers, either a free-radical or a chemical group that may get involved in an ionic polymerization or in a condensation process (Chauhan et al., 2012). Till date, numbers of method have been employed for the generation of active sites on the polymeric backbone such as physical, chemical, photochemical and radiation induced method, etc.

## 3. Applications of Smart polymers

Hydrogels have found extensive application in various fields including drug delivery, tissue engineering and regenerative medicine and barrier materials to regulate biological adhesions contact lenses, membranes separation and adhesives (Fig. 1.6) (Kaith *et al.,* 2012; Feil *et al.,* 1991; Hoare and Kohane, 2008). The discovery of hydrogels brings new transformations in the field of drug delivery because of their enormous properties like porosity, resemblance to natural tissues, biocompatibility, and high permeability rate for oxygen and essential nutrients, tunable viscoelasticity and high water holding capacity.

### 3.1 Drug Delivery Systems

Drug delivery is the process of observing a pharmaceutical compound to achieve a therapeutic effect in humans. The common routes of delivery include the non-invasive peroral, topical, trans mucosal and inhalation (Tan *et al.,* 2012). Hydrogels have a nice porous network. The porosity of hydrogels can be modified by controlling the density of cross linkers used or by changing the swelling efficiency of hydrogels in the environment. This porosity of hydrogels helps in release of drugs. The drug release from hydrogel can be controlled by controlling the diffusion coefficient of drugs through hydrogel matrix. The electro conductive hydrogel of poly(hydroxyethyl methacrylate) and polypyrrole was studied for its application to clinically important biomedical diagnostic biosensors by the assimilation of analyte-specific enzymes (Brahim *et al.,* 2001; Guiseppi-Elie *et al.,* 2001).

### 3.2 Agricultural applications

It is well reported that SAHs are used as water-saving materials for the renewal of the dry and desert environment (Wu and Liu, 2007). They can reduce irrigation water consumption, improve fertilizer retention in soil, lower death rate of plants and increase plant growth due to their outstanding water absorption capacity (Bouranis *et al.,* 1995).

### 3.3 Waste Water treatment

In this modern era, dyes are extensively used in colouring paper, temporary hair colorant and textile industries (Kyzas *et al.,* 2009; Erdener *et al.,* 2000). However, the existence of dyes in the environment contaminates the waste water to a greater extend which causes serious environmental problems.

### 3.4 Removal of heavy metal ions

SAHs are also being explored as removing and separating toxic heavy metal ions and dyes through adsorption as their structure includes -OH, $-NH_2$, $-CONH_2$, -COOH, and $-SO_3$ groups available for activation and modification (Erdener *et al.,* 2000; Kyzas and Lazaridid, 2009; Deepika *et al.,* 2013; Kurniawan *et al.,* 2006; Morris *et al.,* 1997; Yetimoglu *et al.,* 2007; Ali *et al.,* 2003).

### 3.5 Bio sensors for enzymes

Hydrogels have been used to host bioactive layers in several forms of enzyme-linked antibody biosensors and DNA biochips (Pekel *et al.,* 2004, Kim *et al.,* 2004).

### 3.6 Smart textile Materials

Chen et al. (2002) studied the effects of additives on the photo-induced grafting polymerization of N-isopropylacrylamide (NIPAAm) gel onto polyethylene terephthalate (PET) film and polypropylene (PP) nonwoven fabric surface. Temperature sensitive polymer (poly-N- isopropylacrylamide) was grafted on the surface of cotton cellulose fabric by gamma-pre-irradiation-induced grafting (Liu et al., 1999). It was found that grafting reaction was induced mainly by trapped radicals located in the interphase between crystal and amorphous regions, but for the monomers of NIPAAm the peroxides also made some contribution to grafting yields. It was also shown that the surface of grafted fabrics has temperature sensitivity as well. Kuwabara and Kubota (1996) synthesized cellulosic adsorbents by photo grafting acrylic acid onto fibrous carboxymethyle cellulose in the presence of *N,N'*-methylene-bis-acrylamide as a crosslinked agent. Sang-Hoon and Samuel (2003) has reviewed chitosan and its derivatives as antimicrobial agents and their uses as textile chemicals. It was reported that antimicrobial activity and polycationic nature of chitosan have facilitated its uses as a new chemical in the field of textile dyeing and finishing. The use of chitosan in textile involves eco-friendly processes, which substitutes for toxic textile chemicals.

### 3.7 Current and future development

It has been suggested that polymers might be developed that can learn and self-correct behavior over time. Although this might be a far distant possibility, there are other more feasible applications that appear to be coming in the near future. One of these is the idea of smart polymers in textile industries. In environmental biotechnology, smart irrigation systems have been also been proposed. However, smart polymers have enormous potential in biotechnology and biomedical applications.

## 4. Conclusion

This review has attempted the compilation of the most recent advances performed in the field of smart polymers and their applications especially in textile industry. Smart polymers involve the formation of hydrogels and their subsequent application to the material that can be in the form of a fabric, thread, or textile fiber. Smart polymers have already emerged with great potential and enabled the development of various types of drug delivery systems that are biologically inspired. The effects of these developments will at some point be so vast that they will probably affect virtually all fields of science and technology. Over the next couple of years it is widely anticipated that smart polymers will continue to evolve and expand in many areas of life, science, medical sciences. Finally, we have discussed the potentiality of smart polymers in a variety of field.

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