Biopolymer and conducting polymer based nanoparticles for electrorheological fluids.

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In recent years, environmentally friendly and enzymatically biodegradable biopolymers have attracted the attention of researchers. The advantage of these materials is decomposition naturally in nature [1]. Biopolymers are playing important role in nanotechnology. Chitosan is one of the well-known biopolymers and is produced by deacetylation of chitin. The degree of deacetylation directly correlates with its properties. Chitosan has great potential for the biocompatible material production due to its biodegradability, biocompatibility and antimicrobial activity. Also, chitosan is an antibacterial agent and its positively charged chains destroy the negatively charged bacterial cell walls [2].

Electrokinetic behaviors of polymeric materials are very important from industrial point of view. Their colloidal stabilities can be adjusted by the addition of various acids, bases, electrolytes, polymers, and/or surfactants [3]. Electrokinetic measurements are one of the strong tools to investigate the surface properties of particles, interactions between different particles and colloidal stabilities of dispersion systems. Zeta (ζ) potential is a physical property and represents the effective charge of particles dispersed in aqueous medium. It has a great importance in many fields such as food, medicine and materials science. On the other hand, ζ-potential can be measured as a function of streaming current or potential, electric conductivity and electrophoretic mobility [4].

Increasing usage of conducting polymers has accelerated studies on polymer applications in recent years. Conducting polymers have important structural properties such as electrical stability, flexibility, durability and ease of synthesis. Because of their high electrical conductivity and good environmental stability, conjugated conducting polymers are one of the most using materials in the industrial applications. Generally, they are used in the area of solar cells, electrochromic devices, conductive paints, sensors, toners, drug delivery, rechargeable batteries, transistors and electrorheological fluids [5]. Their conductivities can be changed with adding anionic or cationic species called dopant [6].

The ER system is consisting of semiconducting (polarizable) particles and non-conducting liquid phase. ER systems can be classified as smart materials because their rheological behavior is changed with applied electric field strength (E). With the applied E, reversible chain-like structures occur between the electrodes. Therefore, viscosity of the ER dispersion increases under E [7]. All the physical and mechanical properties of the suspensions induced by the applied electric field are reversible [8]. Polarization of the conducting ER particles is due to the motion of electrons on the polymer chains. On the other hand, polarization of chitosan biopolymer as ER material is attributed to amino (NH_2) groups on its chains. [9]. ER fluids have potential applications for a range of electromechanical engineering devices including brakes, clutches, vibration dampers and shock absorbers.

There are two kinds of ER fluids as dry-base ER fluids and wet-base ER fluids. While the dry-base ER fluids show activity without adding any polar promoter, wet-base ER fluids needs a polar promoter to exhibit ER activity [10]. Many semiconducting polymers, biopolymers and polymer/clay nanocomposites are known as dry-base smart ER materials when dispersed in insulating oil. Also, chitosan and cellulose biopolymers have been investigated as anhydrous ER materials [11]. In fact, the high performances of ER materials are closely related to their molecular structures.

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