Fibers as a kind of one dimensional materials with large length-to-diameter ratio and softness have been known and used for thousands of years for making textiles. Fibers can be further processed into yarns, fabrics and can be subjected to well-established textile manufacturing techniques, such as dyeing, twisting, sewing, knitting, etc. The research and applications of fibrous materials are directly related to the daily life and the development of relevant manufacturing industry. However, the conventional fibers and fiber-based devices can no longer meet the automation and intellectualization requirements of modern society, as well as people's consumption needs in pursuit of smart, fashion and distinctiveness.

Smart fibers have dual functions of sensing and reaction at the same time. They can sense changes in external environmental conditions (mechanical, thermal, chemical, light, humidity, electromagnetic, etc.), and adjust their internal structures to respond to the external stimuli in an optimized way. The current choice of smart fiber matrix materials is usually based on petroleum-based synthetic fibers. The non-renewability, poor degradability, and other shortcomings of petroleum-based fibers hinder the long-term development of "green" smart fibers to a certain extent. Biopolymers are known for their natural abundance, unique structures, good mechanical properties, renewability, biocompatibility and biodegradability, low cost and nontoxicity. Biopolymer-based fibers represented by cotton, linen, silk, wool, etc. have been widely used for a long time and the fiber manufacturing process has been very mature, making them perfect candidates for constructing smart fibers. Smart textiles or wearable devices woven from natural biopolymer smart fibers can greatly improve the comfort of smart textiles while fulfilling the target of change detections in various internal physiological activities. Therefore, the research and development of smart fibers based on natural biopolymers can not only realize the functions of other smart synthetic fibers, but also conform to the future development direction of green manufacturing.

This project intends to design several smart fibers based on natural biopolymers, mainly including fast-response thermochromic cellulosic fibers, highly sensitive natural rubber elastic-sensing fibers and magnetically-responsive alginate fibers. The thermochromic fibers can automatically change color reversibly in response to different external stimuli (electricity, light, heat, pressure, solvent, etc.). Smart sensor fibers can convert external stimuli such as mechanical strain, temperature/humidity changes, and various biological/chemical inputs into electrical signals. Magnetically-responsive fibers can respond to magnetic field stimuli leading to magnetically-driven motion of the fibers, magnetic heating/refrigeration or magnetically-driven ordering of nanoparticles within the fibers leading to optical response.

Such composite smart fibers containing responsive nanofillers such as nanoparticles and nanoplates will be fabricated and studied within the project. In particularly, the scientific results of the project should pave the way for design and fabrication of smart biopolymer fibers with numerous potential applications including sensing, stimuli-responsive release of drugs, more efficient and environmentally-friendly refrigeration, and fabrication of magnetically-driven actuators.