# HUMIDITY-SENSITIVE SMART CLOTHES WITH REVERSIBLE RESPONSE

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## ABSTRACT

Stimuli-responsive polymeric materials have attracted enormous interest in recent years due to their ability to generate temporary shape changes and recover their original shape in response to an appropriate stimulus [1-5]. Smart polymers have seen rapid development with applications in a broad range of areas, such as aircraft, smart textiles, sensors, actuators, shape adaptive systems, and biomedical engineering.

Actuation methods play an important role in utilizing smart polymers effectively. At present, solution-responsive polymers are becoming a focus of study to meet the requirements of applications in liquid media such as marine and physiological environments. Water-responsive polymers are desirable, as little energy is required to trigger shape recovery. For example, Huang et al. [6] have reported that water can actuate shape memory polyurethane into different patterns sequentially, and recover the original shapes in sequence. Reversible intermolecular hydrogen bonding is the reason behind these features. Wang et al. [7] have prepared a hybrid that responds to both temperature and water actuations. Humidity-induced, bendable Nafion-based smart textiles have been designed to reversibly adapt their insulation functionality.

Smart clothes are currently a hot topic in smart materials. The future prospects and range of applications for these materials are wide-reaching, and will attract attention from interested readers in a broad range of fields. Nafion known as smart polymers which exhibit shape change and shape recovery properties in response to heating and humidity stimuli.[8-10] When humidity increases, as might occur during human sweating, the pre-cut flaps open to produce pores in the polymer sheet and permit air

flow through the open pores, thus reducing both the humidity level and apparent temperature. If the bendable polymer sheet is inserted between two fabrics, , therincreasing humidity attenuats the inserteby reducing the gap between the two fabrics to impair thermal insulation of the fabric. Humidity-sensitive polymers are able to adjust personal comfort for numerous smart design. This material offers significant promise for future smart products in many areas of science and technology.

Based on the humidity responsive property of Nafion, two different structures are designed to realize the reversible and adaptive functionality in an individual's perspiration level. The first mimics is the sweat pores in human skin and the second one is thickness-changeable structure with ribbon inserted in two layers. A flap array structure on a Nafion sheet can automatically opens or closes flaps to regulate air flow through the pores when exposed to humidity changes. A double layered structure can adjust the air gap and alter the thermal insulation. These smart textile-mimicking structures work in a passive, adjustable, repeatable, and reliable manner.

The ability to fabricate deformable structures with programmable shape-change properties has the potential to significantly impact many areas of our life. Such material is hence of intense interest to researchers in a wide range of disciplines and are the focus of much current activity and investment.

KEYWORDS: Humidity response, Reversible structure, Personal thermoregulation, Smart clothing

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