Novel Skin-friendly Polymers

Topical film formers for sunscreens and adhesives for attachment of ostomy bags are examples of polymers designed for contact with the human skin. Such products may be improved by application of state-of-the-art knowledge on polymer surface chemistry.

Gore-Tex, a fabric co-invented by Wilbert Gore and his son Robert Gore, allows sweat to exit from within a raincoat while not hampering the coat's ability to resist rain. A research group led by Associate Professor Esben Thormann is looking to achieve the same thing for sunscreens and polymer adhesives in direct contact with the human skin.

"The specific solutions will be very different since sunscreens and polymer adhesives are not really similar to a raincoat, but the image illustrates our fundamental challenge. It is well known that sweat and bathing dampens the effect of sunscreens considerably. Similarly, adhesives that attach ostomy bags and other medico-technical products to the body will gradually deteriorate because of moisture at the skin surface. Both types of products can be improved significantly, if we succeed in transporting moisture swiftly away from the skin surface," explains Esben Thormann, who is heading the group on Polymers and Functional Interfaces.

The relevance of the idea is underscored by the strong industry involvement. While Innovation Fund Denmark is the main sponsor of the project – with DKK 12.2 million – two companies contribute significantly to the total budget of DKK 22.5 million. Coloplast is a world-leading supplier of ostomy bags and a range of other medico-technical products. Riemann is a dedicated supplier of high-end sunscreens with strong long-lasting protective effects.

Allowing the skin to breathe

"The two companies do not have any mutual commercial conflicts as they operate in completely separate markets. Yet, their fundamental problem in relation to this project is very similar. Their products can benefit considerably if we identify paths to remove water from the skin surface," Esben Thormann states. "We note that the two companies not only contribute to the funding, but are also highly active with significant internal resources allocated in relation to the project."

The potential benefits reach well beyond the competitive advantages for the involved companies. The annual societal cost of skin cancer is estimated to DKK 250 million in Denmark alone. Exposure to direct sunlight without sufficient protection is known to be a contributing factor. Sunscreen with better ability to withstand sweat can thus hopefully help to reduce the large number of skin cancer cases.

Similarly, adhesion failure represents a large discomfort for ostomy bag users. Should the bag suddenly detach, this may lead to highly unpleasant and difficult situations. The notion alone, that this could happen will impose insecurity and psychological stress.

"A supplier like Coloplast needs to balance the need to prevent adhesion failure with the discomfort associated with excessively adhesive products. If the product binds too strongly to the skin or hamper the skins' ability to breathe it may lead to dermatological problems. Our idea is to manufacture an adhesive which on the one hand binds strongly, but at the other hand allows the skin to breathe," says Esben Thormann.

Water transporting polymers

As the two companies may seek commercialization, the specific ideas for improvement of their products cannot yet be revealed. However, Esben Thormann is able to outline the broader scope.

"Textbook graphic illustrations of polymers usually give them as prolonged molecules with a strong tendency to curl up. However their physical functionalities can be moderated by various either chemical or physical changes and different chemical and physical structures can lead to different water transporting and water storing capacities."

An obvious example is a diaper. Here, polymers are able to hold surprisingly large amounts of liquid, while keeping baby's skin fairly dry. However, while a high water storing capacity is the main functionality of a diaper, a new water transporting property of sunscreens and polymer adhesive is a secondary property which cannot significantly affect the products primary functionalities. Thus, for these products the solutions are much more complex.

Further improvements ahead

Actually, Esben Thormann hopes to be able to improve these types of polymers even further:

"This is not a part of the before mentioned project, but we are also conducting studies on so called responsive adhesives. The idea is to synthesize adhesives which can be altered by either physical or chemical changes. For instance, certain polymers can be strongly adhesive at room temperature, but if heated above a given threshold temperature, the adhesion suddenly decreases."

Again, a possible application could be for an ostomy bag:

"You want the bag to be strongly attached, but when it is time to remove the bag, it would be nice if you could remove it easily without causing any harm to the skin. If the adhesive is sensitive to temperature this could be achieved by use of a heat source like for instance a hair dryer. Alternatively we might be able to use light or a chemical change to achieve the desired effect."

Also, the applications might be for adhesion of other medico-technical products, or in entirely different fields.

"I never liked the idea that a scientist should be either engaged in fundamental or in applied research. It is highly satisfying when one is able to inspire development of new products in cooperation with industry, but at the same time we also need to do research which is primarily driven by curiosity. Just now, the efforts on responsive adhesives are curiosity-driven, but I have a feeling, industry applications will open up. It is a typical feature of polymer surface chemistry that the road from fundamental research to application is often very short."

SEVERAL PROJECTS ON POLYMER SURFACES

Besides the joint industry project highlighted in the article, the group on Polymers and Functional Surfaces is currently engaged in several other major projects. One is on "Biomimetic and responsive adhesives for a challenging biological environment". This project with a budget of 2.6 million DKK is sponsored by the Danish Council for Independent Research (DFF) / Technology and Production. Another project regards "Studies of tuneable inter-chain forces in highly charged poly(ionic liquid) brush layers". It is sponsored by the Danish Council for Independent Research (DFF) / Natural Sciences, also with a budget of DKK 2.6 million.

CONTACT

Associate Professor
Esben Thormann
esth@kemi.dtu.dk