'Swiss army knife' molecule

February 16 2016, by Fabio Bergamin

The coating polymer is versatile – like a Swiss army knife. Credit: Colourbox.de

Scientists at ETH Zurich and an ETH spin-off have developed a novel polymer for coating materials, in order to prevent biofilms from forming on their surfaces. Thanks to the technological platform developed, it is now possible to coat durably a variety of different materials using the same polymeric molecule. Such coatings are of relevance for medical applications, among others.

Internal and external qualities are two different things - the same holds true in materials science. For example, in many cases a specific material

would, in principle, be ideal for a technical application were it not for the fact that its surface is unsuitable.

Materials scientists solve this problem by coating the material. Coatings can be used to make a surface lubricious, for example, or - in underwater applications or the biomedical sector - to prevent algae, proteins or bacteria from fouling the surface over time. For example, hydrophilic polymers are often used to protect metals from fouling; water molecules accumulate on this polymer layer, which protects the metal against the adhesion of unwanted molecules or organisms. However, many coatings currently in use are not very resistant to environmental factors, since they are often connected to the material by only a weak electrostatic bond. Other existing, more resistant coatings are expensive to use and sometimes require toxic solvents.

Strong chemical bonds to a wide range of materials

Scientists led by Nicholas Spencer, Professor of Surface Science and Technology, and researchers at the ETH spin-off Susos thus searched for a simple solution to binding coating molecules to surfaces with a strong chemical bond, known as a covalent bond. They also wanted to find a solution that could be used to coat a range of surfaces and devices composed of several different materials. "We wanted a polymer coating that is as versatile as a Swiss army knife," says Spencer.

And that is just what the scientists succeeded in developing. The molecule has a long backbone from which hydrophilic side chains branch out and impart the non-fouling properties. The polymer also has two types of side chains for covalent bonding to metals - one for binding to silicon and glass, the other for binding to oxides of what are known as transition metals, which include titanium and iron.

Dip and rinse

"Coatings with our new polymer are very simple. It's just dip and rinse", says Spencer. "And the coating withstands even harsh conditions such as acids, alkalis, high salt concentrations and detergents."

The ETH spin-off Susos has submitted a patent application for the polymer. The scientists see possible applications mainly in biomedical diagnostics and medical technology, such as in biosensors, implants and future implantable drug-delivery systems. Other applications could include biofouling prevention in water treatment, ship transport, and fishing, as well as the food industry, for example in packaging.

The "Swiss army knife" in its current form is highly adaptable and opens the door to a host of further developments. As Spencer explains, it would be possible to equip the polymer's molecular backbone with side chains that bind to other materials, or to replace the side chains that prevent biofilm adhesion with others that have totally different properties.

More information: Ângela Serrano et al. Imparting Nonfouling Properties to Chemically Distinct Surfaces with a Single Adsorbing Polymer: A Multimodal Binding Approach, *Macromolecular Rapid Communications* (2016). DOI: 10.1002/marc.201500683

Provided by ETH Zurich