Copper ions as morphogens for the formation of polymer films by click chemistry

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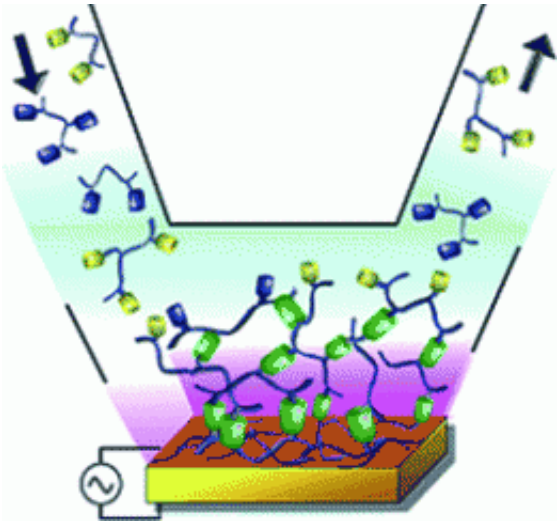

(PhysOrg.com) -- Scientists are envious of nature because of its ability to build up highly complex structures like organs and tissues in an ordered fashion without any problem; it takes a great deal of effort for scientists to produce defined microscale structures. Pierre Schaaf and a team of scientists from Strasbourg have now imitated a few of nature's tricks in order to get a polymer film to "grow" onto a surface. As the researchers report in the journal *Angewandte Chemie*, they used morphogens as nature does. These signal molecules show a reaction

which way it should go.

The growth of our bones, seashells, or the complicated forms of diatoms, requires the processes involved in biomineralization to occur along precisely controlled tracks. Molecules cannot simply be allowed to react in an uncontrolled fashion as soon as they encounter each other. In order for a complex organism to develop, every individual cell must know where it is located within a growing organ. Special signal molecules called morphogens inform the cell. They are formed in a specific location and then spread out into the surrounding tissue. This results in concentration gradients, which the cells can use to "orient" themselves.

Schaaf and his co-workers chose a similar strategy to form thin films on a substrate. They also used a sort of morphogen to steer the process. The reactants involved were polymers, one containing azide groups (- N_3) and the other with alkyne groups (- C≡CH) as side chains. In the presence of positively charged copper ions (Cu^I), these groups react with each other to form a carbon- and nitrogen-containing five-membered ring, crosslinking the polymers. This type of reaction is called "click chemistry", because the reaction partners simply snap together.

In a solution containing both click partner and Cu^I ions, the reaction would immediately proceed at random. This would not result in a thin polymer film. The scientists' idea was thus to place the Cu^I ions as a morphogen only on the surface to be coated. Their approach was to place Cu^{II} ions in the solution. They then applied an electric voltage to the surface. When Cu^{II} ions come into contact with this surface, they take an electron to become Cu^I. These are thus primarily to be found on the surface. Where there are Cu^I ions, the click reaction can proceed; the polymers only crosslink into a continuous film on the surface. The magnitude of the applied voltage can be used to control the number of Cu^I ions and thus the thickness of the film.

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More information: Pierre Schaaf, Electrochemically Triggered Film Formation by Click Chemistry, *Angewandte Chemie International Edition* 2011, 50, No. 19, 4374 - 4377, dx.doi.org/10.1002/anie.201007436

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