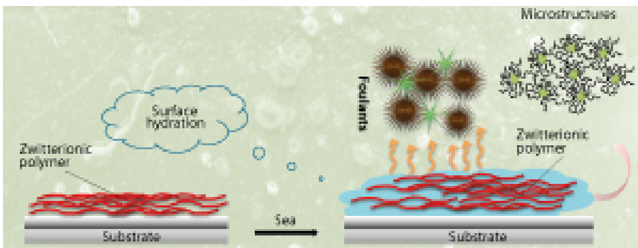
Polymeric material that changes its structure when immersed in salt water

April 1 2015



The block copolymer alters its structure in response to salt solution, enabling it to survive intact in dynamic marine environments. The material may prove useful for creating non-toxic alternatives to antifouling paint used on boats. Credit: A*STAR Institute of Chemical and Engineering Sciences

'Smart' materials that alter their structure in response to specific, controllable stimuli have applications in various fields, from biomedical science to the oil industry. Now, A*STAR researchers have created a self-assembling polymeric material that changes its structure when moved from water to an electrolyte solution, such as salt water. The material could help improve coatings used to protect surfaces from the build-up of biological contaminants, particularly surfaces under the sea.

Materials composed of segments of two different monomers, each with different characteristics, are known as block copolymers. Vivek Vasantha at A*STAR Institute of Chemical and Engineering Sciences—together with scientists from across Singapore under the

Innovative Marine Antifouling Solutions (IMAS) program—developed a new block copolymer that can self-assemble into spherical micelle structures in which one monomer forms the core and the other forms the outer shell. The monomers are the hydrophilic poly(ethylene glycol), or PEG, which mixes well with water, and the halophilic polysulfabetaine (PSB), which has a preference for salt solution.

"We created salt-responsive block copolymers that self-assemble in water to form either 'conventional' or 'inverse' micelles," states Vasantha. The conventional micelles form in deionized water and have a core of halophilic PSB with a hydrophilic PEG shell. However, the team showed that the micelles re-assemble themselves when immersed in salt solution; PEG formed the core, and PSB formed the shell to create an 'inverse' micelle.

"The material is easily controlled by salt alone, rather than by a combination of several stimuli like pH, temperature or light, which some other smart materials require," explains Vasantha. "It appears to be highly tolerant of fluctuations in pH and temperature too, which means it is potentially useful for dynamic marine environments."

The researchers mixed the block copolymers with primer to create a non-toxic coating to replace traditional antifouling paint. Current coatings to prevent fouling by marine organisms include toxic chemicals, and become ineffective after a short time because the additives in the coatings break down rapidly in sea water.

Vasantha's team applied the new coating to glass slides, which they then immersed in the sea for two weeks.

"The antifouling behavior of coatings is normally tested in laboratory experiments," says Vasantha. "Throughout our unique marine tests, the self-assembling micelles kept the coated surfaces intact and the coating displayed reasonable antifouling behavior by preventing settling by organisms such as barnacles."

The researchers anticipate that their smart material will have other potential applications in enhanced oil recovery and biomedical science.

More information: Vasantha, V. A., Jana, S., Lee, S. S.-C., Lim, C.-S., Teo, S. L.-M. et al. "Dual hydrophilic and salt responsive schizophrenic block copolymers – synthesis and study of self-assembly behavior." *Polymer Chemistry* 6, 599–606 (2015). dx.doi.org/10.1039/c4py01113a

Provided by Agency for Science, Technology and Research (A*STAR), Singapore