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Medical implants

Anti-fouling polymers demonstrate star quality

Star-shaped polymer coatings show promise in fending off bacteria and blood clots in medical implants

Two polymers, designed by researchers at the Nara Institute for Science and Technology (NAIST), may herald a new class of 'anti-fouling' coatings for medical implants such as heart valves and catheters[1].

The problem with implants, made from silicone or polyethylene terephthalate (PET), is that cells tend to stick to them. When blood platelets (which promote blood clotting) attach to an artificial heart valve, for instance, there is risk of thrombosis, while adherent bacteria can cause secondary infections.

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The researchers, from NAIST's Graduate School of Materials Science, suspected that a coating of star-shaped polymers — in which polymer chains radiate from a central polymer ball — would make it difficult for bacteria and platelets to attach. "We wanted to build a brush-like surface," says corresponding author Tsuyoshi Ando, "but without the cumbersome steps of surface chemistry." Rather than attaching the star-polymer 'brush bristles' using covalent chemical bonds — difficult to do, as PET is quite inert — they designed star-polymers with hydrophobic chains that were naturally attracted to the PET surface (see figure). "We chose polymethyl methacrylate (PMMA) as our model hydrophobic compound for attachment to the PET," says Ando. The team synthesized three star-polymer varieties: some made purely of PMMA, some made from poly 2-hydroxyethyl methacrylate (PHEMA), and 'hetero' star-polymers containing both PMMA and PHEMA. They then coated small strips of PET with the polymers.

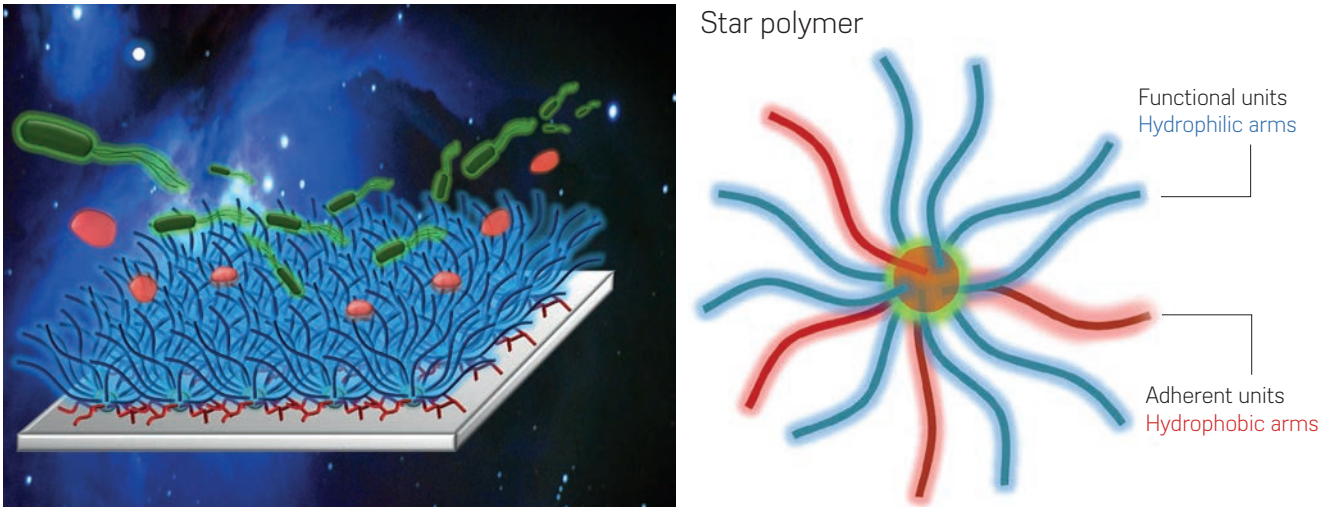
Ando's team had expected the hydrophobic PMMA stars to attach well to the PET surface, and indeed it proved the most durable coating trialled. However, the PMMA stars were not very good at preventing platelet attachment.

The hetero stars provided the best of both worlds: the PMMA chains allowed them to cling to the PET surface, while their PHEMA chains discouraged clotting and bacteria. "We had some surprises," says Ando. "We designed the hetero-star as a first step, and expected they would show moderate inhibition of platelet and bacterial adhesion. But they exhibited much higher inhibition than we expected." The PHEMA stars inhibited platelet adhesion effectively too, and to the team's surprise, they attached well to the PET surface. "They were still attached even after seven days of being washed with a surfactant," says Ando. "We think these two 'stars' are promising materials for non-platelet adherence."

Ando thinks improved versions of these star-polymers could prevent bacterial 'fouling' not only in devices in contact with body fluids, but "also on surfaces like the toilet bowl or sink."

Reference

1. Totani, M., Ando, T., Terada, K., Terashima, T., Kim, I. Y. *et al.* Utilization of star-shaped polymer architecture in the creation of high-density polymer brush coatings for the prevention of platelet and bacteria adhesion. *Biomaterials Science* **2**, 1172–1185 (2014).
2. Totani, M., Ando, T., Terada, K., Terashima, T., Kim, I. Y. *et al.* Inside front cover. *Biomaterials Science* **2**, 1138–1138 (2014).



Schematic of (left) the 'brush-like' star-polymer surface and (right) a star-shaped heteropolymer.

More information about the group's research can be found at the Biocompatible Materials Science Laboratory webpage:
http://mswebs.naist.jp/LABs/tanihara/index-e.html