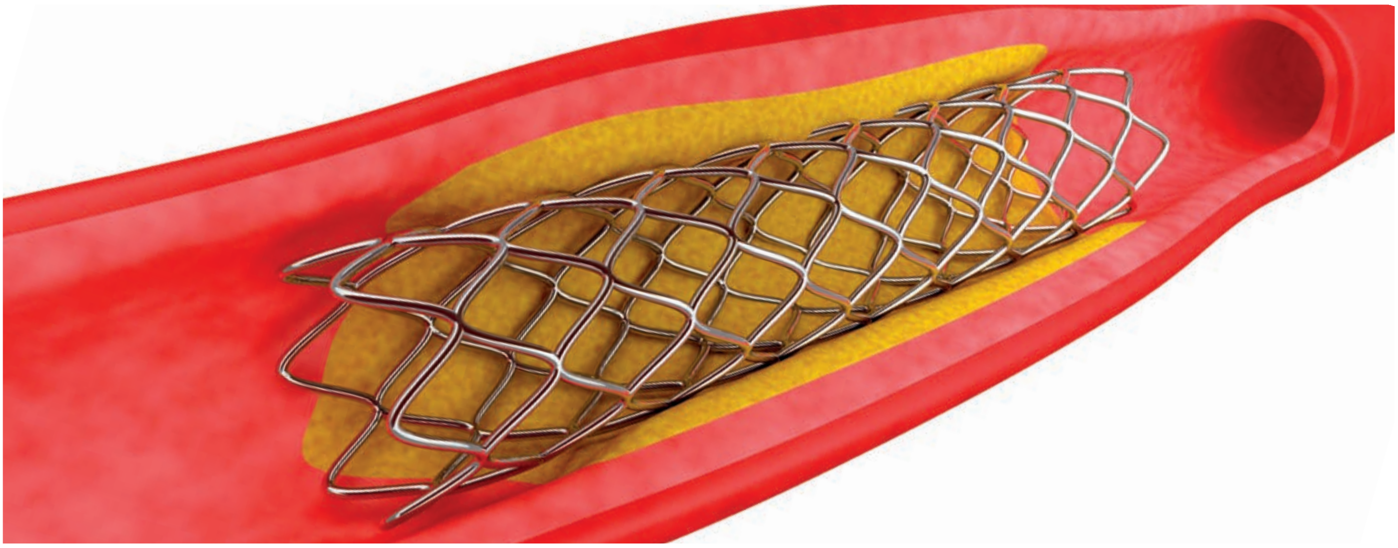
NAIST® Research Highlights

Nara Institute of Science and Technology | **Nanomaterials and Polymer Chemistry Laboratory** www.naist.jp/en



Block copolymer films are promising candidates for stent coatings for controlled drug release.

Polymer chemistry

Switchable surface wettability

Switchable spin-coated surfaces hold promise for controlled drug release in medical applications

Controlled drug release is essential for a range of medical treatments, from contraceptive implants to chemotherapy and vaccinations, and a popular option is the use of drug-eluting stents (see figure). The key to this controlled release is being able to manipulate the surface characteristics of the stent coatings — namely, their wettability and degradability.

Hiroharu Ajiro, formerly of Osaka University, now leading the Nanomaterials and Polymer Chemistry Laboratory at Japan's NAIST, investigated different block copolymer films to see which afforded 'switchable' wettability (transitioning between hydrophilic and hydrophobic behaviour) and slow degradability.

Block copolymers are large polymer chains consisting of 'blocks' of simpler polymers. Ajiro and colleagues decided to focus on spin-coated films consisting of block copolymers of L-lactide (LA) and trimethylene carbonate (TMC) derivatives with methoxyethyl groups. They then systematically investigated the surface structural control of their films using contact angle measurements, X-ray photoelectron spectroscopy and degradation behaviour analysis.

There were some challenges that the researchers had to overcome to fabricate these coatings, including designing the monomers and synthesizing the polymers to use as 'blocks'. Ajiro emphasizes that it was particularly important to attain a balance, "both between the hydrophilic and hydrophobic properties, and between the soft and hard domains of the polymers."

Ultimately the researchers prevailed, producing controllable coatings based on poly(TMC) and poly(LA) — with contact angle measurements showing dynamic changes between hydrophobicity and hydrophilicity[1]. The films were tested in two different solvents: water and hexane, exhibiting hydrophilic and hydrophobic behaviour, respectively. This switchable wettability is believed to be due to the interactions in the copolymer between the TMC polymer main chain and the methoxyethyl functional groups — the reorientation of the copolymer making different moieties aggregate on the surface, thereby influencing its wettability.

Understanding the degradation of the films is of particular importance for biomedical applications: the time the film takes to break down must be appropriate for its intended use. Ajiro's team compared the degradation speed of amorphous and crystalline poly(LA) films to their coating, and found that the degradation was markedly slower for the crystallized block copolymer film — making it a much more appropriate coating for long-term drug release.

Ajiro, who is also a researcher with the Precursory Research for Embryonic Science and Technology (PRESTO) programme of the Japan Science and Technology Agency, notes that these films hold great promise for a range of applications, not just in the medical field but for anything that requires "a switchable coating surface without degradation conditions."

Reference

1. Ajiro, H., Takahashi, Y., Akashi, M. & Fujiwara, T. Surface control of hydrophilicity and degradability with block copolymers composed of lactide and cyclic carbonate bearing methoxyethoxyl groups. *Polymer* **55**, 3591–3598 (2014).

More information about the group's research can be found at the Nanomaterials and Polymer Chemistry Laboratory webpage:
http://mswebs.naist.jp/english/courses/1844/