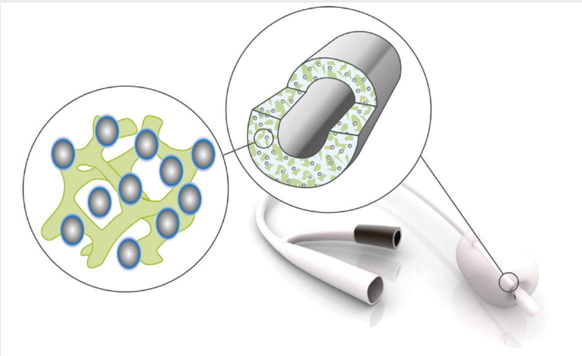
Silicone Alley

Silicone is frequently used for medical tubing because of its chemical inertness and flexibility. However, a common issue with silicone medical tubing is the formation of bacterial biofilm inside and outside the tube which can lead to infections. Indeed, catheter associated urinary infection (CAUTI) is the most common type of hospital acquired infection (HAI) today, but the problem exists for other types of medical tubing as well.

In response to this problem, Danish biotech company BioModics developed the interpenetrating polymer network (IPN) technology which impregnates silicone with so-called hydro gel. This makes the material hydrophilic (i.e. will allow water penetration) which in turn effectively prevents the formation of bacterial films on the surface of the material. Equally important however, is the fact that the hydrogel creates its own internal network in the silicone material. This network can work as a drug reservoir and dispensary, for instance for anti-microbial peptides.

BioModics turned to LINX to increase its knowledge about how exactly the silicone and the hydrogel is distributed in the matrix on the molecular level and what this means for the properties of the material.



The impregnated hydrogel material functions as a reservoir and transport facility inside the IPN matrix. The silicone changes from an impenetrable material into a semipermeable membrane and can now release the loaded substances in a controlled long-term fashion. This is especially interesting for drug delivery applications.

Peter Thomsen, CEO, BioModics: *We needed to go beyond the lab and into the nanoscale level. Our collaboration with NBI within LINX is now in its second year and it continues to generate valuable new knowledge for us.*

The issue

Various analytical methods exist today which allow some insight into the 3D structure of the silicone-hydrogel matrix. However, these methods are limited in the resolution and information they can achieve. To fully exploit the unique properties of the IPN material, BioModics needed 3D information on a nanoscale level. They wanted to know how a model drug behaved inside the matrix. Supported by small angle scattering techniques, BioModics needed assistance to develop the mathematical and structural models required to better understand and predict drug transport in the matrix.

What we did

Through LINX, a collaboration was set up between BioModics and scientists at the University of Copenhagen's Niels Bohr Institute (NBI). The scientists employed Small Angle X-ray Scattering (SAXS) and Small Angle Neutron Scattering (SANS) techniques to obtain new information on BioModics' IPN material on a nanoscale level.

They compared samples of silicone with and without hydrogel. To highlight the hydrogel structure, it was loaded with heavy water (D2O). By that, the utility of these analysis methods was confirmed.

The objective is an analytic model that can satisfactorily describe and predict the structure and properties of the IPN material, and this model is now being developed based on the data obtained.

What's next?

In the second part of the study the partners will further investigate how the loading of the hydrogel into the silicone and the parameters around it, such as temperature and humidity, affects the structure of the material. They will also study if stretching of the material changes its properties. Further large-scale neutron facility experiments will yield important additional structural data during 2018.

Biomodics Reimagine silicone
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