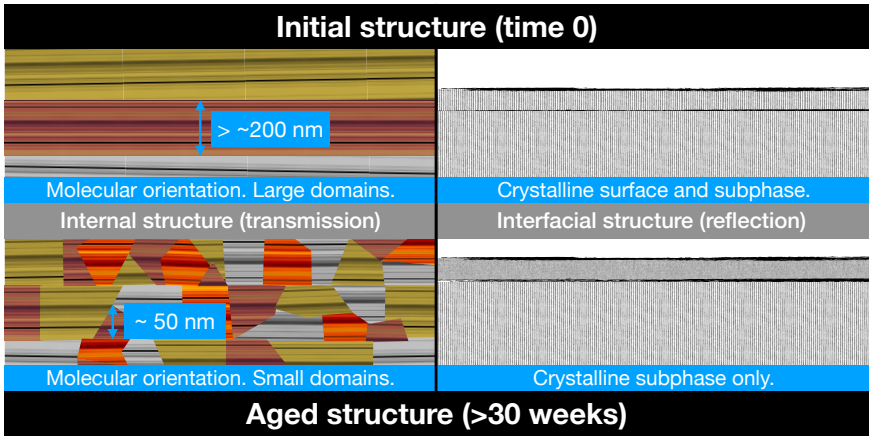
Liquid crystalline polymers for protecting sensitive equipment

In this project, scientists from the University of Copenhagen, Aarhus University, and Grundfos investigated liquid crystalline polymer (LCP) materials that could provide a viable and energy-efficient alternative to metal casings.

Protecting sensitive machinery and electronic parts from the ingress of water when immersed in wet environments is crucial for Grundfos. It is not always beneficial to use metal casings, either due to weight, communication or electrical issues. LCPs are a new possible material avenue for such applications as they are typically highly resistant to the permeation of water yet offer the versatility of injection moulding.

Of key interest was the long-term stability of the LCP materials when exposed to water and elevated temperature, and a series of materials exposed for extended periods of time (more than a year) were studied with small-angle X-ray scattering (SAXS) and X-ray diffraction (XRD). These methods revealed the changes in the nanoscale and atomic structure of the materials after exposure.



SAXS and XRD in combination show how the LCP structure changes with prolonged exposure to water. Initially, the LCP domains are larger than 200 nm but break down into smaller nanoscale domains after prolonged exposure. The material retains a high crystallinity and high degree of molecular orientation even when the domain size becomes small, but the crystallinity of the surface layer is lost after very long exposure times.

What we did

- LCP samples with different polymer base and with different filler material were exposed to water for up to 60 weeks at 110 °C.
- All samples were measured with SAXS at University of Copenhagen to study changes in nanoscale structure.
- All samples were measured with XRD at Aarhus University to study changes in atomic scale structure.
- SAXS and XRD data were analysed and compared to give an understanding of the structural changes in the LCP material when water enters the material from the surface to the bulk.

What's next?

The next step could be to study the relationship between the measured structural parameters and important process parameters such as bursting pressure.

"We have removed a key uncertainty for Grundfos with the investigations of the project. We initially did not quite understand why LCPs behave very differently from the other polymers we work with. We now understand the permeation mechanism for these polymers and can pave the way for commercialization in our products."

- Allan Hjarbæk Holm, Lead Materials Specialist, Grundfos.

In the LINX project, researchers at leading Danish universities collaborate with scientists in industry to solve industry relevant problems using advanced neutron and X-ray techniques. The Arleth group at University of Copenhagen contributes with their expertise in small-angle scattering techniques.

Read more
linxproject.dk

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