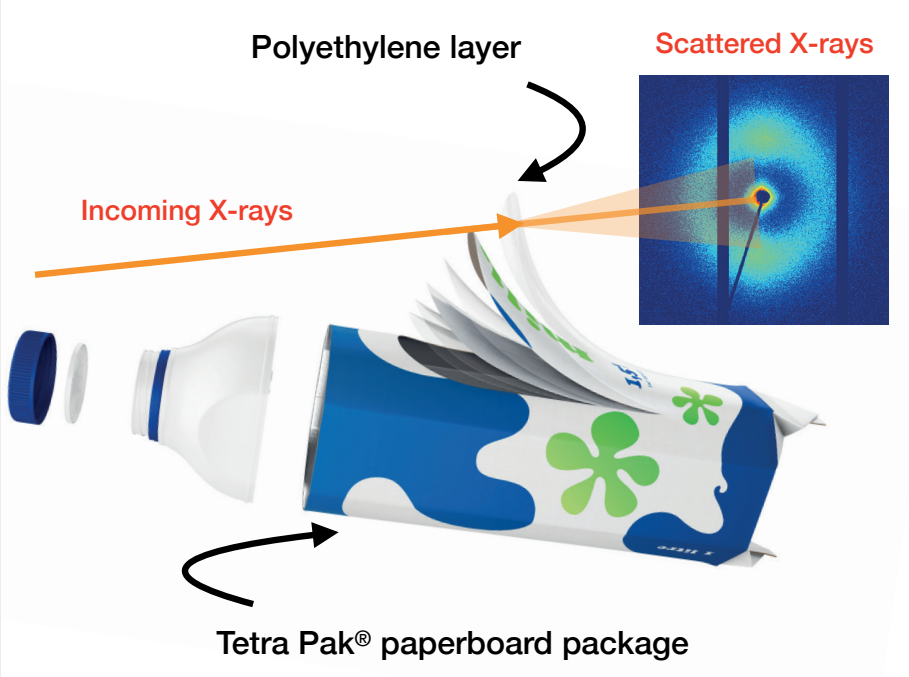
X-ray Scattering from Thin Polymer Layers

In this project, researchers from University of Copenhagen collaborated with Tetra Pak® to study the crystalline structure of extremely thin polymer layers used in the packaging industry. X-ray scattering measurements made it possible to correlate differences in the properties of the polymer films to differences in their corresponding structures.

Although the main material in Tetra Pak® packages is paperboard, polymer films and metal foils are essential to ensure a robust package. Thin polyethylene layers both prevent the ingress of moisture and act as an adhesive between the paperboard and the metal foil.

The thin polymer films are formed in the extrusion coating line by cooling molten polymer very rapidly at high flow speeds. The polymer molecules quickly cool and are far from equilibrium. Consequently, it is difficult to predict the structures formed. Techniques that can study the thin films directly, both after they are produced and while they are mechanically deformed, will help to relate the structure of the polymer molecules to the performance of the polymer film.



Polyethylene layers act as a barrier and adhesive for Tetra Pak® paperboard packages. X-ray scattering measurements on one of the polymer films show that crystals in some films have a preferential orientation originating from the process used to produce them.

What we did

- Tetra Pak® manufactured and isolated thin micrometre-scale films of extrusion-coated polymer with different material compositions.
- A procedure was developed to obtain good quality X-ray scattering data on the thin polymer films using instrumentation at the University of Copenhagen, which was challenging as they were so thin.
- X-ray scattering data were obtained during tensile stretching of the films to relate polymer structure to mechanical properties.

What's next?

The structure of extrusion-coated polymer layers will be studied in real time during tensile stretching using synchrotron X-ray scattering, to obtain structural data that can explain the performance of the layers in packaging. This is possible due to higher intensity and fast acquisition times available at an X-ray synchrotron.

"With the developed methodology we can characterise and compare the morphology, structure and material orientation after manufacturing and during mechanical deformation of thin extrusion coated polymer films."

- Anna Svensson, Technology Specialist, Tetra Pak®

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 & tetrapak.com

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