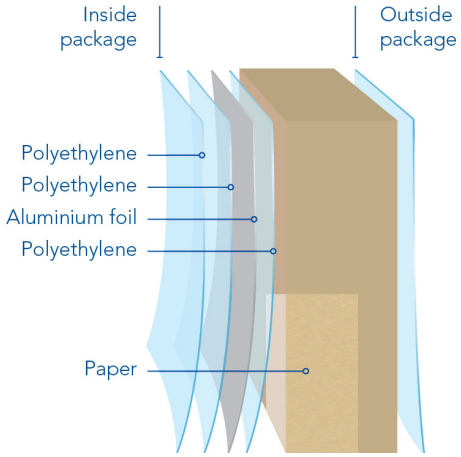
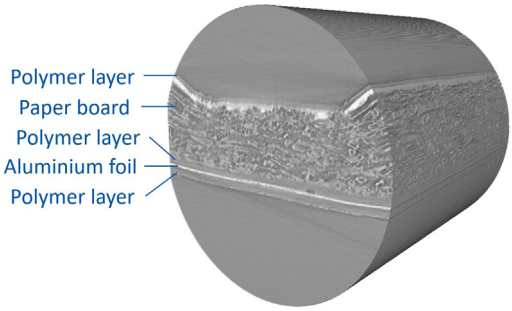
Detecting individual layers in laminar materials

Tetra Pak is the world´s leading food processing and packaging solutions company. To predict and control the behavior of the materials which are used for packaging, Tetra Pak is committed to virtual engineering using digital 3D models. To obtain reliable virtual models, it is important to know the exact geometry of the actual products. In this project, we have studied the geometry of packaging materials using X-ray micro computed tomography and advanced image analysis.



Layered stucture of a Tetra Pak carton.



3D rendering of a CT scan showing the different layers.

Challenge

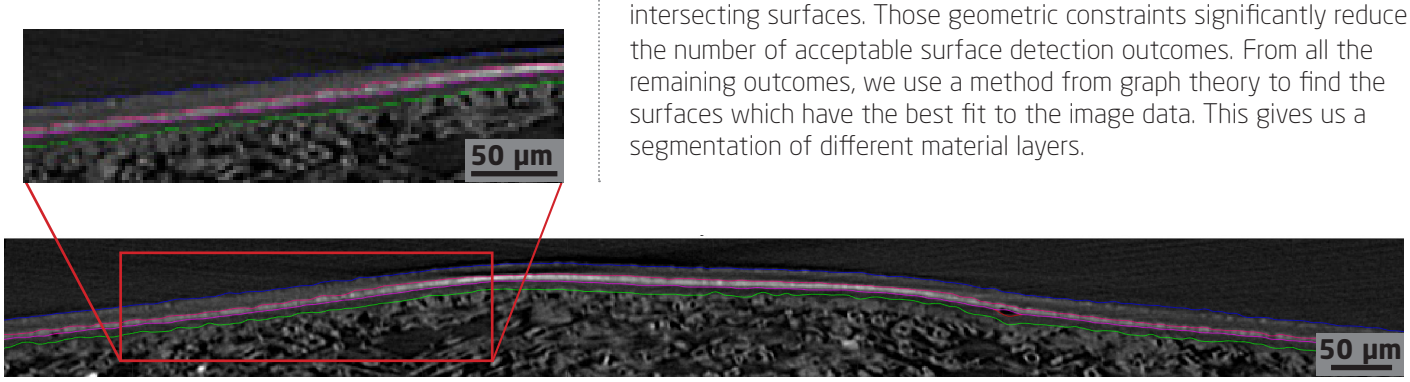
Carton packages for liquid food products are made of a laminar material consisting of a paper board, thin layers of polymers and a layer of aluminium foil. To obtain the true geometry of such a material, we need to distinguish its components – a task known in image analysis as segmentation. In images obtained using X-rays, the aluminium is relatively easy to segment as it appears bright compared to the paper board and polymer. In contrast, distinguishing the paper board from the polymer is far more challenging, due to the complex structure of the paper board and only a small intensity difference between the polymer and the background.

Collaboration

Through the collaboration between Tetra Pak and the 3D Imaging Centre at DTU, the material was characterised using micro X-ray computed tomography scans and in-house developed analysis tools. This collaboration was part of the LINX project in which researchers at leading Danish universities collaborate with scientists in industry to solve industry relevant problems using advanced neutron and X-ray techniques.

Results

To obtain the true geometry of the packaging material we utilise its layered structure. This means that we only need to find surfaces which separate the different layers. For that, our knowledge of the sample is incorporated, i.e. the paper board, the aluminium and the polymer may be modelled as terrain-like, smooth, layered and non-intersecting surfaces. Those geometric constraints significantly reduce the number of acceptable surface detection outcomes. From all the remaining outcomes, we use a method from graph theory to find the surfaces which have the best fit to the image data. This gives us a segmentation of different material layers.

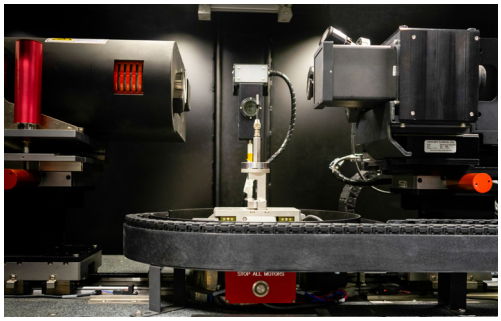


Ortho slice of the layered material indicating the segmented aluminium layer (pink) and the polymer layers (blue and green).

Imaging Industry Portal

The Imaging Industry Portal is a part of the 3D Imaging Centre at DTU and assists companies in using and implementing 3D Imaging in research, development and production. The portal offers research-based 3D Imaging services and provides companies with the latest equipment and the most advanced knowledge within 3D Imaging and data analysis. The Imaging Industry Portal works as a gateway to ESS and MAX IV, as well as other large scale facilities.

www.imaging.dtu.dk/Industry-Portal



DTU 3D Imaging Centre