PREPARATORY INDUSTRIAL PROJECT

Adaptation of biaxial tensile setup for in-situ loading with X-ray scattering

THE INDUSTRIAL CHALLENGE

Packages for food and dairy products are commonly composed of multiple layers of different materials that together form a laminate. The integrity of each layer is crucial for the structural stability of the package and its ability to protect the product inside. During the converting and filling machine processes, the material in each layer is subjected to complex multi-axial deformation during e.g. creasing and folding. In order to fully understand the mechanical performance of the packaging material for optimised material design, it is important to study the material layers under as process-like conditions as possible.

WHY USING A LARGE SCALE FACILITY

To understand the underlying deformation mechanisms responsible for the mechanical behaviour of material, small- and wide-angle X-ray scattering can be used. In order to study the evolving microstructure, it is important not to stop the macroscopic deformation as this will lead to relaxation of the material. Only the high X-ray flux available at synchrotron facilities allows for experiments with continuous macroscopic deformation. For this reason, the possibility to perform biaxial or multiaxial loading complemented with X-ray scattering was investigated at the MAX IV synchrotron in Lund.

HOW THE WORK WAS DONE

This project has investigated which specifications a biaxial tensile test machine must fulfil in order to be used for in-situ experiments at a synchrotron facility. The project has specifically investigated the modifications needed to adapt an existing custom-made apparatus for in-plane biaxial loading, available at the Division of Solid Mechanics, Lund University, for use at the CoSAXS and ForMAX beamlines at MAX IV. Through in-depth discussions among the involved project partners at Tetra Pak and Lund University, a list of specifications for a biaxial device has been compiled. During the course of the project, beamline experts at MAX IV has been consulted about the demands on a sample environment, put forth by the beamlines.

THE RESULTS AND EXPECTED IMPACT

Compared to when performing conventional mechanical testing, samples environments for in-situ experiments at large scale facilities are often subjected to more restrictive demands. The investigation conducted within this project has resulted in a list of specifications that a sample environment for X-ray scattering and in-situ biaxial deformation measurements must fulfil. In addition to limitations in size and weight of the device, the specifications include requirements for flexibility in terms of, e.g., interchangeable sample holders. The results from this project will form the basis for the design of a new, custom-made tensile test device.

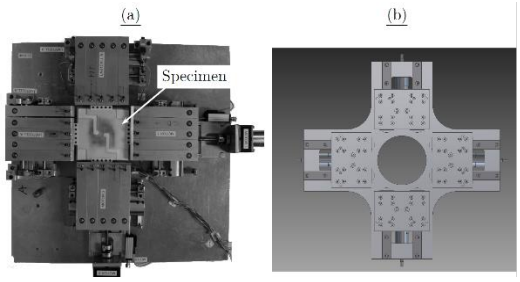

Figure. The existing biaxial tensile test device (a) and an initial draft drawing of a new design based on the knowledge gained in this project (b).

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