EMMC case study:

Modelling Drop Impact Test of Flexible Pouches Made of Thin Polyethylene Films

Interview of Hein Koelman, Dow

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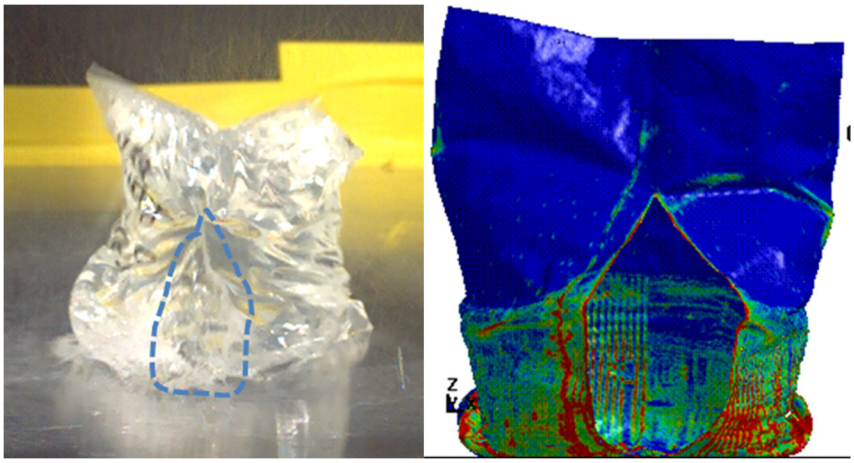
Digital Mock-up



Drop Impact test and simulation

About the Company

Dow is a leading global Materials Science company with headquarters in Midland, Michigan, USA. They employ more than 40000 people on a full-time basis. In R&D, a significant effort is in the market driven invention and development of new materials and formulations, and introduction and support of materials at customers in their applications. The people involved with materials modelling typically hold a PhD when they start working at Dow. Materials modelling has been established at Dow for more than 30 years now and the modellers enjoy internal and external training opportunities. Modelling has gradually

become an integral part of the R&D efforts so no noticeable surge in the need of material and data driven modelling expertise occurred.

About modelling – the nuts and bolts

Dow is familiar with electronic, atomistic, mesoscale, continuum and data-based modelling and uses multiscale -modelling to link smaller lengths scales to continuum models. The company is using commercial, in-house, and open-source software for data driven modelling on a daily basis. The computational expertise is advanced, so they will always match the type of modelling to the application/problem, i.e. use different types of modelling for different applications/problems. When Dow is interested in fundamental research they will regularly embark on collaborations with partners from academia. Dow prefers to do modelling themselves rather than using 3rd party contract research. They are also keen to learn new techniques via training provided from software vendors. The company will use modelling if they need information or insight which cannot be gained via any other means. If insight can be gained by simple and fast experimental tests, they tend not to use modelling.

About the Case Study

The case is based on a market demand for novel and lightweight flexible food packaging replacing rigid forms of packaging, including rigid plastic, glass or metal. These “pouches” are indeed very lightweight and also do not take up much volume when disposed of. However, the value chain and end consumers have certain expectations in terms of the handling, processing, aesthetics, feel and robustness of such packaging. Packaging manufacturers want materials that can be readily formed into a pouch and then easily be filled with content and sealed. Logistics wants to be able to stack these pouches on pallets and survive packaging and transportation loads. Retailers want them to have an appealing appearance, be stable on a shelf, and survive a drop. The consumers want a product that does not undergo unintended tear, feels nice, does not puncture easily, allows the right amount of content to be dispensed easily, and does not fall over in the cupboard if partially filled.

For this particular case, which were your objectives as an industrial consumer of modelling?

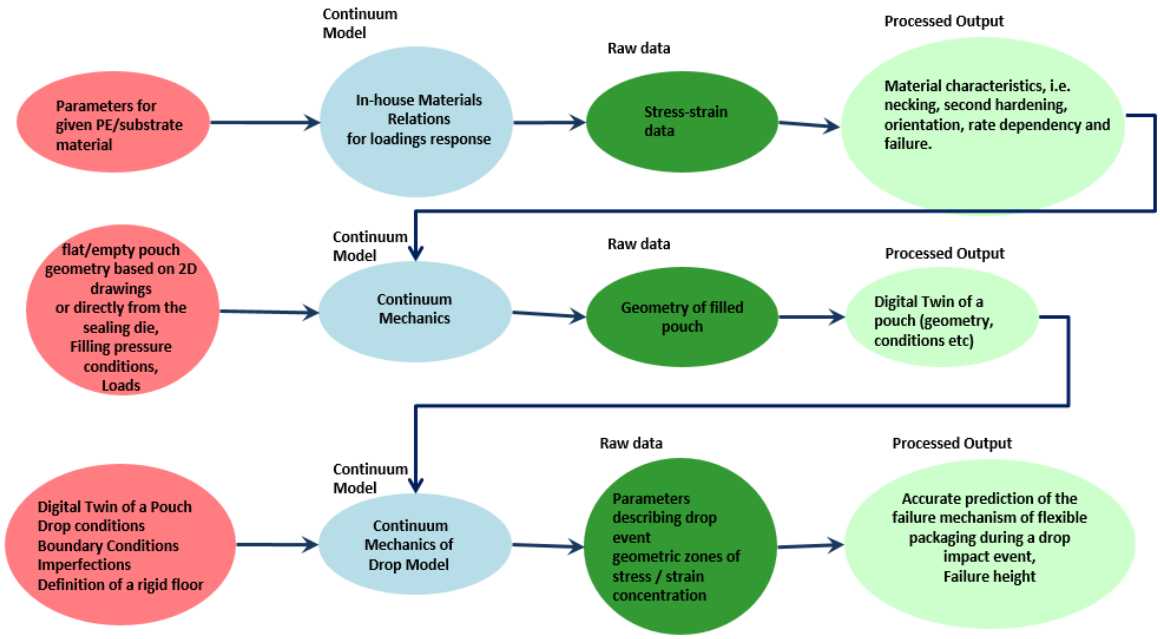
The objectives were to fulfil the need of customers who expected an application with a certain behaviour. Dow had to translate what the requirements for a material had to be to have a certain behaviour and link materials’ characteristics to this behaviour. In this case, they had to find out what the characteristics of a plastic film should be to show a good performance once turned into a pouch. The objective was to develop and use modelling capabilities to predict the behaviour and performance of new-to-develop pouches and to be able to design end engineer most efficient film structures and the resins used for these pouches. So effectively modelling would link the specific characteristics of resins and film structure with the performance of a new pouch design.

How did materials modelling play a key role in problem solving?

Through the value chain, new packaging is typically developed through experience and testing, with in some cases many iterations. With modelling they could predict the performance of a resin and film structure in the end-application and understand the material-performance relationship much better with fewer iterations.

What tools and methodologies have been applied?

A combination of in-house tools and methods for describing and modelling the resin and very complex film structure characteristics and commercial finite element software for modelling the pouch performance. Below, the workflow is shown using a MODA (MOdelling Data) template:



What were the expected improvements of the material behaviour simulation?

It was expected to get better insight into the materials selection for resins to meet the customers' application criteria. One of these were that the pouch needs to survive a drop without bursting open. Thus, simulations were anticipated to allow Dow to advise customers on which materials to use for the film. The customer could then avoid costly trial and error experiments and it took them less time to develop the packaging.

For this particular case, did modelling affect your value chain?

Overall modelling helped to accelerate developments of a new package through the value chain. By using modelling, Dow could better predict *the effect resin and film characteristics* would have on the end product. By understanding which types of properties were needed, new materials and formulations could be suggested. Dow's approach was to design a digital mock-up of a pouch, conduct in-silico drop-tests on it, and then visualize what happened during a drop to the material. This accelerated development times and allowed Dow's customers to set up manufacturing processes based upon the outcomes of Dow's modelling work. Dow also utilized modelling to support efforts to develop structures and packaging which have improved recyclability.

For this particular case, what was the quantitative value of materials modelling?

Due to the customer needing fewer iterations and therefore less testing, new package formats come to the market faster and less money and resources are spent during development.

What investments were made during the project?

Dow had to develop the integrated modelling capability which included state-of-the-art methods to model the complex behaviour of the thin multi-layer film structures. For this, investments were also made in developing specific tests to generate input parameters for the resins and film. Dow also invested in developing methods to capture the fluid-structure interaction of the flexible package with its content. All this needed internal funding for resources, software and testing.

For this particular case, how did you measure the impact of Materials Modelling as a tool to assist in problem solving, process optimisation, product development?

The modelling team had well defined Key Performance Indicators (KPIs). In this case, they were KPIs for a new pouch design. The impact was measured in terms of how fast a package can be developed with the selection of the right Dow materials and how fast input can be given to customers on specific questions on resin and structure selection. We also considered the overall impact of spending time on modelling and less time/resources on testing versus not using modelling. Generally, each project has to have an acceptable Return on Investment (RoI).

What technical and technological benefits resulted from the project?

Modelling at Dow aided with the design and development of new packaging, meeting the customer's needs faster, and increasing insight on the relationship between resin and film structure on the one side and package performance on the other side.

What where the economic benefits/impacts when you did use modelling?

Overall speed to market for new packaging through the value chain and ability to do more valuable projects with a given set of resources.

What was the business impact versus previous approach?

With modelling, customers could reach the right package design in a shorter timeframe. This success allowed Dow to increase our level of partnership in the value chain and establish Dow as a technology leader and solution partner

Did modelling improve your competitiveness/innovation power?

Yes, modelling gives Dow more innovative power and helps them to stay ahead of their competitors. It supports Dow as a leader and preferred supplier/partner in this industry.

What sort of obstacles or barriers did you have to overcome to use modelling?

It took effort to convince all stakeholders within the company to invest in the capability development as there were risks on the ability to build a truly fast and predictive capability and do this within a reasonable time. The risks were also on the ability to capture and predict the very complex behaviour of the thin multi-layer film in models.