

# How injection compression moulding yields excellent lens performance



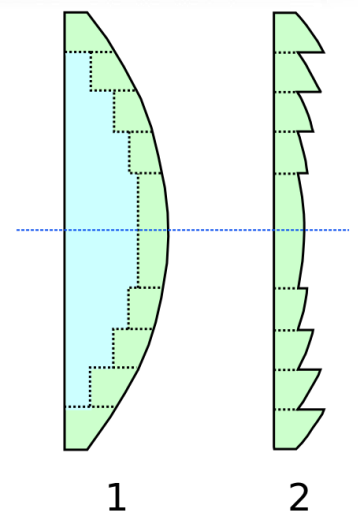
*As the first Dutch nursery to do so, Ter Laak was able to build and run the innovative and energy-saving Daylight Greenhouse. The results were beyond expectations: a stronger crop is produced with accelerated growth to the next cultivation phase.*

*Thanks in part to the Fresnel lenses produced by Pekago using **compression injection moulding**, an energy saving of no less than 50% was achieved with the building of the Daylight Greenhouse. The building of the 50,000 m<sup>2</sup> Daylight Greenhouse for orchids was started in 2017, and it started production in 2018.*

## **The Daylight Greenhouse: energy-efficient and brand new**

Technokas Ingenieursbureau B.V. is the inventor of the Daylight Greenhouse. This greenhouse is characterised by the use of Fresnel lenses. A Fresnel lens is ideal for capturing light and is therefore frequently used in, for example, lighthouses, stage lighting and searchlights. A new application was found with the Daylight Greenhouse where sunlight is captured by collectors in the Fresnel lenses. When there is too much light, the direct light is captured, leaving diffuse light to enter the greenhouse.

The concentrated sunlight heats up the collectors and they collect energy from the greenhouse. This energy is stored and reused in various high-tech ways. Another important component is the biaxial 'solar tracking system' that keeps the collectors aligned with the lenses. The lenses lie in a cavity of insulating glass with an anti-reflex coating. The result is an extremely sustainable greenhouse that consumes little or no energy on balance and creates an optimal greenhouse climate by providing the plants with constant perfect lighting.



*Schematic representation of the principle of the Fresnel lens in cross-section:*

*1. A conventional spherical plano-convex lens showing its productive ring-shaped segments.*

*2. A Fresnel lens, which comprises the productive ring-shaped segments only.*

## Partners in development

During the development of the lenses, Technokas searched for the right material, which of course had to be extremely transparent and capable of transmitting ultraviolet light. A partner was found in the German company [Evonik](#), which could provide the desired material, so-called Polymethyl Methacrylate (PMMA).

The likewise German mould builder [Hofmann](#) drafted a 3D design for the Fresnel lens based on Technokas' wishes and requirements. After collecting the necessary 3D data, Hofmann performed a mould flow analysis as a check prior to the injection moulding process being performed. Hofmann built a mould with a dual, independently-controlled (cascade) hot runner system using high-quality hardened tool steel.

## Injection compression moulding

The details of the lenses developed needed to be sprayed so accurately and with such dimensional stability that 'normal' injection compact moulding turned out not to be an option. However, this could be realised with injection compression moulding. Pekago has mastered both techniques.

### *Injection compression moulding is a variant of injection moulding*

*With this technique, the plastic is injected while the mould is not yet 100% closed. As soon as the right amount of plastic has been injected into the cavity, the mould closes with high force and the material is pressed against the mould wall. This ensures that the details of the mould are perfectly transferred to the product. Injection compression moulding is generally used when tensile stress in the product must be avoided and a high surface quality is required.*

## Pekago, manufacturer of the Fresnel lenses

During the construction of the mould, Technokas went looking for a manufacturer that could manufacture the plastic lenses (a first batch of 100,000 lenses) using injection compression moulding. Outside the company's available capacity, a specific injection moulding machine was also required that met a number of conditions:

- at least 1500 tons of closing force;
- compression moulding capacity;
- cascade facility (sequential injecting at several injection points);
- small shot volume (2500 to 3000 cc) owing to the product weight of approx. 700 grams.

[Pekago](#) could meet all of these requirements and it has extensive expertise in the field of injection compression moulding. Freelancer, Alex Peiksmas, brought Technokas and Pekago together.

## Limiting the risks by using a comprehensive plan of action



Frank Paenen

"Pekago was involved in the project when mould construction was already well under way. But fortunately Pekago was on hand to provide the expertise necessary to ready the mould for production on the most suitable machine. In fact, a number of steps had to be added before production could start", said Frank Paenen, who, as Pekago's account manager, supervised the entire process from order to delivery of the first batch. "Of course, we adhered to a detailed plan of approach, as we do with all our projects."



*Removal of the first Fresnel lenses from the mould*

The plan of approach included the following steps:

- Inspection of the mould construction involving fitting and connecting it to Pekago's injection moulding machine;
- Attending the toolmaker's test injections;
- Product validation by Technokas during the test injections;
- Drawing up and discussing the test report following the test injection;
- Mould optimisation as a result of the test injections and Pekago's input;
- Product release;
- Mould and process release by Pekago on site at the toolmaker's injection moulding machine;
- Approval of the mould's transport to Pekago in the Netherlands for serial production.

Frank told us that an extensive entry check was naturally performed after the mould's arrival at Pekago. "As soon as the mould had been assessed and the last modifications had been made, another test injection was performed. To also save as much time as possible in this phase, the customer was again present at this test injection so that the products could be immediately validated and released for serial production."



### **Product inspection**

"Not only was the functioning of the mould checked, the first products were also thoroughly inspected by, for example, measuring the scattering of light passing through the lens along a line. Of course, it goes without saying that their dimensions and surface contamination were also checked", Frank continued.

*Measuring and assessing the light output*

### **Packaging and transport**

"Packaging is often seen as a less important part of the production process. It does not get the attention it deserves and this can result in unnecessarily high costs at the last moment.

For the packaging of the Fresnel lens, we chose a rectangular box. However, across its width the box has space for a hand so that the product can be placed in the box and stacked without causing damage. The extra space in the box is then filled such that the products are held firmly. This method allows us to pack and transport the products safely and quickly."

### **Serial production of the Fresnel lens**

Pekago manufactured the 100,000 Fresnel lenses over a period of five months using a 24/5 production schedule. The weekends were used as a buffer period and to perform weekly maintenance on the mould.



*The first greenhouse under construction*

## About Technokas



Technokas Ingenieursbureau B.V. designs and realises complete greenhouse construction projects, climate installations and business premises for entrepreneurs throughout the Netherlands. They use the latest techniques, materials and insights of new cultivation methods to design ever smarter, innovative greenhouses. You can find more information on Technokas at [their website](#).

## About Hofmann



Hofmann is a tool and mould manufacturer based in Germany, that has all the processes in-house to develop, perform feasibility analyses and make moulds of outstanding quality. More information on Hofmann can be found at [their website](#).

## About Pekago



Since 1983, Pekago Covering Technology has specialised as a system supplier in the development, engineering, mould construction, production and assembly of plastic housing elements and technical components for the manufacturing of industrial equipment. Pekago excels in the successful integration of design, function and manufacturability and the realisation of cost targets. For more information on Pekago go to [our website](#).