Polymer Optics Automotive Ltd

General Presentation
Polymer Optics Limited (POL) was founded in 1998.

POL's Engineers each have over 30 years experience in optical design and plastics optical manufacturing.

POL is an Optical Design AND Manufacturing Consultancy specialising in plastic optics and optical systems …

…… however, POL supplies most of its customers with product via partner manufacturers.

Advanced experience in wide range of manufacturing processes and process development.

Advanced experience in secondary processes and process development

Diverse experience in optical systems for specialist applications for:

Automotive   Aerospace   Industrial   White goods   Mobile Phones   Medical   Scientific

Polymer Optics Automotive Limited subsidiary was formed in 2014 to enable POL to better develop this business area and resource it accordingly
POL uses a number of the latest computer optical design softwares for advanced 3D “un-constrained” optical raytracing, photometric analysis and imaging systems design.

This range of powerful commercial softwares are further enhanced by our own in-house developed design programs, which give POL specialist capabilities for novel types of optical applications.

These advanced optical ray tracing and photometric mapping routines give real-world simulation results of the optical system to demonstrate the design performance and in many cases remove the need for prototyping before moving to production tooling.
Optical Design and Analysis

Arm Rest and Door Facia Lightguide Interior Ambient Lighting Analysis

Door Pocket Interior Ambient Lighting Lightguide Analysis
Optical Prototyping

SLA (Stereolithography), SLS (Selective Laser Sintering) - Mechanical Parts, housings, etc.

Clear SLA – Clear colourless resins for windows, lightguides and simple lens components

SLA to Vacuum Casting -  SLA model sealed and polished then used as master for silicone rubber tool.
Parts cast in clear polyester resins - expect 70-80% of production performance.

Direct Machining - CNC machining and polishing of cast PMMA acrylic and precision diamond turning

Rapid Tooling -  Aluminium tools can be made in 3-10 days - not good optical finish.
Soft steel tools can be made in 4-8 weeks - not fully hardened, but good optical finish.
Fully hardened steel production tools - 6-12 weeks - best performance and life.
Optical Tooling and Manufacture

Partner tooling and volume manufacturing plants selected throughout Europe, Asia and USA.

Air conditioned, clean-room optical moulding and assembly operations through to low-cost, commodity manufacturers.

POAL can design and supply optical solutions to meet its customer’s needs, world-wide.

Optical inserts managed by POAL and supplied to tool makers for fitting.
POAL works with a large network of partner suppliers around the work to provide global manufacture to its customers and be able to implement a wide range of process capabilities into our products.
POAL works with a large network of partner suppliers around the world to be able to implement a wide range of process capabilities into our products. A large number of POAL’s partners are based in the UK to enable close development of novel products, tooling and processes, which can then be transported as turn-key operations to other geographic regions for mass manufacture.
POAL’s wide range of partner suppliers enable us to implement novel design and manufacturing approaches to supply cost reduced, leading edge products to our global customers.
POL/POAL has developed light control techniques over many years to give fine control of light distribution and evenness of displays.

Dot density distribution and light scattering properties of the etched dots can be varied to control illumination extraction and evenness

Very high repeatability in the laser machining and in the injection moulded product from the tool.

Patterns can be etched directly to plastics for prototyping stages, too.
Imaging Optics and Camera Lenses

With the increase in miniature cameras being used in vehicles for parking assist and all-round vehicle presence monitoring, POAL can design and manufacture miniature camera lens systems for visible and IR applications.

The Dyson 360 Eye is fitted with a panoramic lens designed by POAL, giving the robot vacuum cleaner 360 degree vision.
Plastics components can be coated in poly-siloxane and acrylate based resin blends to impart more robust properties:

- Glass-like look and feel
- Dirt resistant, non-stick properties
- Abrasion resistance to scuffs and scratches
- Chemical resistance to harsh reagents and environments
- Boiling water resistance for sterilisation processes and harsh environments
- Anti-fog properties
- Anti-microbial properties

Dip coating gives widest flexibility in coating geometry and coating thickness control for thermally cured coatings, where as precision spray coating gives production automation advantages for UV cured resin systems.
In-Mould-Label Optical Manufacture

POL has developed IML techniques for both decoration and optical applications:

- Abrasion Resistant Hard Coating
- Product Decoration
- Surface Textures – Natural Finishes

Optical Functionality:

- Anti-reflection <0.3% reflectivity
- Dichroic filters
- Mirror surfaces
- Heat reflection
Silicone Optics

**Optical:**
- Excellent transparency giving high light transport efficiency
- No yellowing under high temperatures and prolonged high UV exposure
- High colour and mechanical stability gives prolonged product life

**Mechanical:**
- Flexible resins giving high impact resistance
- Thick and thin component sections can be moulded accurately with no sinks
- Flexibility of the resin allows undercuts to be accommodated in the part design
- Seals can be moulded into the optic, reducing need for secondary sealing on assemblies
- Optics have intrinsic vibration dampening and shock resistance
- Minimal compression set under deformation loads
- Enables over-moulding onto light sources and other components
- Hardness – 70 Shore A and other hardnesses available for specialist applications

**Environmental:**
- High thermal resistance from -40°C to 150°C
- High chemical resistance

POL Standard 570 and 571 Silicone Optics
Polymer Optics Automotive Limited
Projects
Nissan Juke LCD Illumination

POAL was contracted to redesign the LCD illumination for the X12C Nissan Juke vehicle to improve light-bleed and low contrast problems.

The illumination back-light was made up of three injection moulded parts:
Lightguide, rear-reflector and bottom-reflector

POAL’s raytrace analyses showed the stray light causing the light bleed problem at the top edge of the LCD display.
POAL re-designed and retooled the lightguide component, while maintaining all of the previous mechanical fits and functions.

Also, the product assembly was reduced to only two components:
Lightguide and a die-cut reflector-label

…. saving on tooling and component costs

The light input features were designed to remove the stray light problem from the LCD area

Nissan Juke LCD Illumination
POAL’s illumination measurement techniques help quantify the problem, then quantify the improvements.

The improved display contrast has reduced illumination test rejects on the Juke assembly line, reducing rework and costs.
POAL developed the interior illumination system for the 2014 Nissan Qashqai which draws on POAL’s wide polymer optical product development experience to introduce some novel product features:

- 500mm long lightguide illuminated from one end only, saving cost in the electronics and wiring harness.
- Laser etched tool surfaces provide precise light extraction and intensity in areas where required.
- Cross-section of lightguide designed for easy clipping into assembly with no light losses.
- Lightguide is hard coated for abrasion and chemical resistance against various reagents.
- Design for Assembly (DFA) and Poka Yoke techniques used to reduce cost and ensure reliability.
POAL’s light control techniques allow the light output from the top section of the lightguide to be over 10X brighter than the lower section, to achieve the illumination styling design intent, even though the top section is furthest from the LED source.

The subtle lightguide design, maintains efficient light transport, even around the sharp bend at the point of the knee bolster.
Infiniti Q30 Illumination – Cup Holders

POAL single-piece design with a simple housing component and PCB assembly.

Housing and PCB Poka Yoke designed for simple, reliable assembly.
POAL design uses a single-piece Poka Yoke designed housing component for simple, reliable assembly.

Infiniti Q30 Illumination – Pad C

Ambient light feature projected from Pad-C dash-board section, on to top edge of the glove-box surround.
POAL design advantages:

- Simple “line-of-draw” tooling construction for the housing part
- Clip features formed in the engineering plastic housing part for better resilience and reliability
- Lens component made in hard acrylic, for better clarity and no hard coating protection required
- Only two simple side actions required on the outside of the lens part allowing insert changes inside for different optical functions
- Closed assembly gives dust and water splashing protection to meet NDS specifications

Infiniti Q30 Illumination – Interior Light
POAL design, developed and prototyped the arm rest illuminations and map pocket illuminations for the new 2017 Land Rover Discovery 5.

Analysis of Customer Lightguide Design

Analysis of New POAL Lightguide Design
JLR Discovery 5 Door Illumination

2017 Land Rover Discovery 5 production lightguides and assemblies in the carrier chassis with light engines
Free-form Optics

POAL has developed free-form optics for reading lights in automotive interiors, because the illumination can be efficiently and accurately controlled into the required beam foot-print.

Also, the normal “key-stone” distortions of the beam, where the beam is projected at an angle to the target area, can be corrected.

POAL has developed free-form optic solutions for vehicle Manoeuvring Lights, where the illumination can be projected from front to rear of the vehicle from the door-mirror mounted position.
Projected Illumination

POAL designs illumination methods to project logos and other shaped illumination areas inside and outside the vehicle for foot-wells, luggage areas, manoeuvring lights and curb-side courtesy lights.
Watermark Logos

Watermarks can be placed within the illumination of lightguides to show logos, text or function symbols, etc.
POAL has developed a lightguide based solution to give a uniformly illuminated, complete 360 degrees ring of illumination.

This technology only uses one LED to illuminate the entire 360 degrees ring of even, seamless illumination.

Prototype Ring Illumination Demonstrator
POAL’s 360 degrees lightguide technology can be used for cup-holders and other inner and outer ring illumination applications, giving a complete ring of even, seamless illumination.
The POAL GloWorm® technology has a wide range of applications where specific areas of a vehicle interior are to be illuminated with a defined foot-print of light, such as armrests, console walls, door pocket interiors, etc.

For example, in a typical door pocket illumination design, where the lightguide is mounted in the pocket edge to illuminate the facia of the door lining, the shape of the door facia will change the distance between the lightguide and target surface. This will give a variation in the illumination brightness and foot-print width across the door facia target surface. However, with POAL’s GloWorm® technology, we can control the illumination brightness, width and position at every point across the door facia, to give an optimum, uniform, aesthetically pleasing, illumination scheme.

... and if we can do that, we can correct for almost any automotive interior illumination geometry or produce unusual illumination effects.
GloWorm®’s capability to control the direction of the illumination from the lightguide, as well as the beam width and intensity along the lightguide, allows the illumination foot-print to be shaped to the target surface.

This beam shaping can be used to control the beam foot-print on contoured target surfaces, but can also be used to create a straight illumination area from a shaped lightguide path.
GloWorm® Illumination

Shaped illumination from a simple lightguide!

In a typical map pocket application, using GloWorm®, the light projected from a shaped lightguide path, can be designed to evenly fill the entire shape of the map pocket aperture.

Standard lightguide in vehicle door pocket

GloWorm lightguide applied to the same door pocket
To demonstrate POAL’s design, development and prototyping capabilities in automotive lighting, we have retrofitted a number of illuminations into an originally non-illuminated Alfa Romeo 156 door.

This involved digitising the door parts then designing lightguides around the existing features and fixings, which of course, is more difficult than a new product design, where we can change the internal features.
Door Pocket GloWorm® Illumination

POAL’s GloWorm® technology applied to an RGB lightguide concealed along the top edge of the door pocket.

This illumination is achieved with a single multi-colour LED and gives completely colour mixed light, projected to fill the entire door pocket volume with even intensity.
Panel “Wash” Illumination

POAL’s standard lightguide illumination, using laser machined light control structures, is a very compact design solution to be concealed in a minimum package space.

This allows single colour or multi-colour illumination to be applied to a wide range of interior design schemes in both projected illumination and directly viewed lightguide applications. Oblique illumination projected down decorative interior panels, highlights the subtle textures.
Bezel Feature Illumination

POAL's laser machined lightguide techniques, allow the light to be piped around long complex paths to illuminate a wide range of features.

The door-pull bezel is illuminated by only one RGB LED source, where the lightguide fits around the internal features of the door-pull assembly, but maintaining the flow of light to achieve even illumination.
POAL’s illumination techniques allow the best use of the light to provide different illumination effects.

By advanced control of the light propagation and light extraction evenness controlled by POAL’s laser machined structures, complex illuminations can be produced with a minimum of LED sources.

This saves cost and makes colour uniformity easier to control.

Inner and outer speaker grill illuminations achieved with only two LEDs, while piping the light around mechanical fixings and maintaining perfect colour mixing of RGB illumination.
POAL’s 360 degrees lightguides, illuminated bezels and many other interior and exterior lighting features can be combined with transparent chromium and other decorative finishes.

These decorative finishes have to be carefully designed into the target illumination system, to compensate for the light filtering effects of the chromium coatings and to take best advantage of the decorative effects provided by the bright chromium or satin finishes.
POAL Design Advantages

✓ The most optimum illumination performance can be designed within the product constraints

✓ The optics can be designed to make best advantage of design for assembly (DFA) techniques

✓ The product can be engineered to give the most cost effective solution

✓ That doesn’t necessarily mean cheap components!! But best cost to performance balance and savings enabled elsewhere in the product

Best Performance  →  Lowest Cost  →  Biggest Advantage
Automotive Interiors Publicity

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Thank you