



USE OF COMPOSITES FOR REAR CLOSURES

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ABSTRACT / INTRODUCTION

When INOPLASTIC OMNIUM, the Joint Venture between PLASTIC OMNIUM AUTO EXTERIEUR and INOPLAST, was born in 1998, its production of composite liftgates and trunks was 400 parts / day. In 2000, IPO produced 800 liftgates / day, and this expansion went on to reach 2,500 parts produced daily in 2003.

In the same time, other Tier 1 suppliers had a similar growth: in 2000, 3.2 % of European liftgates were made of plastic, whereas they are 4.7 % in 2003, and this number is still growing.

This evolution raises the question: "why is the use of composite rear closures so interesting?".

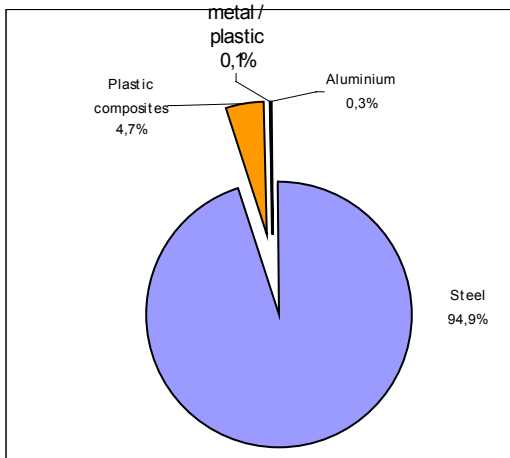
The composite solutions for rear closures present several technical, economical and industrial advantages. We will highlight some of those advantages in this paper, and illustrate them on precise examples, coming from the experience of IPO on its current productions:

- Weight reduction
- Antenna, interior trim, and exterior cladding integration
- 15 kph insurance rear impact management
- Capital investment reduction
- OEM industrial management: cycle time improvement and harmonization

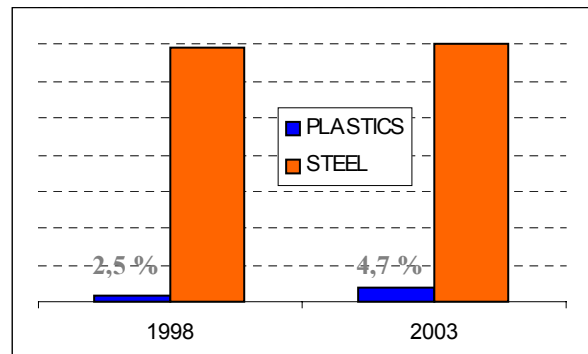
We will also show how the new improvements of automotive Tier 1 suppliers on closure function and on materials & processes can bring composite liftgates and trunks new advantages.

EUROPEAN PLASTIC CLOSURES MARKET

In 2003, the number of European cars using plastic materials for rear closures accounts for 4.7 % of the total number of cars. Steel liftgates represent 94.9 % of the market. The plastic liftgates and trunk lids are a minority, but another important data must be noted: in 1998, the percentage of plastic closures was of 2.5 %.

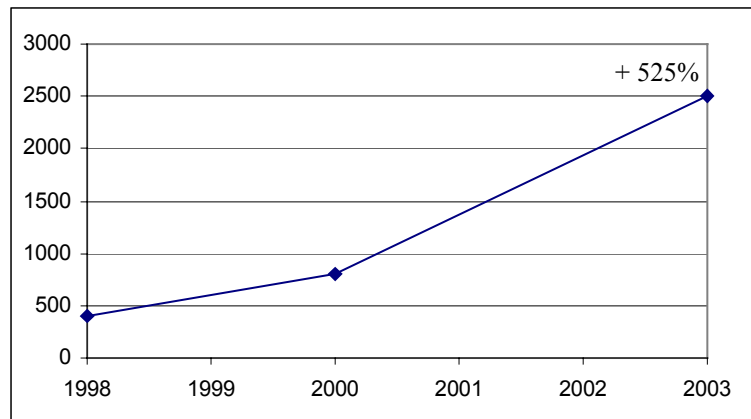


Plastic vs. other materials in 2003



Plastic vs. steel - evolution 1998 - 2003

During this time, INOPLASTIC OMNIUM, multiplied by more than six (6) times its closures production. Also the number of European carmakers using plastics on the rear closure was multiplied by three (3).



Number of IPO closures production / day

This quick evolution in the past five years raises the question: “why is the use of composite rear closures so interesting?”. Some of the interests of the plastic closures are listed below and will be highlighted during the conference.

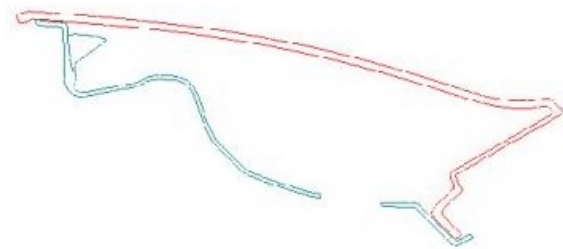
WEIGHT REDUCTION

The use of a plastic liftgate usually brings a 20 to 25 % weight savings with the same rigidity results. Depending on the complexity of the closure, the weight saving can be up to 30 %. Example: on the BUICK Rendezvous, the weight saving was of 30 % compared to the initial steel design.

This weight saving is obtained not only thanks to the use of plastic materials which are lighter than steel, but due to the function integration possible in plastics. For example, the integration of the rear spoiler in the VOLVO XC90 plastic liftgate skin helped saving around 2,5 kg.



VOLVO XC 90



VOLVO XC90 spoiler integration, section Y201

FUNCTION INTEGRATION

The use of plastic materials on the structure and skin of the liftgate allows some function integration:

- New functions can be implemented in the closure – ex. : Antennas
- Existing functions can be integrated in the plastic parts, reducing number of parts and thus reducing weight, quality defects, and number of references – ex. : Interior trim, exterior claddings ...

Antenna integration

The interior and exterior plastic skins are transparent to radio waves, which allows the antennas to be located between both. Consequently:

- The antenna is protected against thieves and vandals
- The appearance is improved (non visible antenna)
- The assembly is easier: assembly before bonding of the exterior skin on the inner skin
- The water-tightness is improved: no hole in the roof

This integration is particularly valuable in the case of trunk lids, in which a large horizontal surface exists.

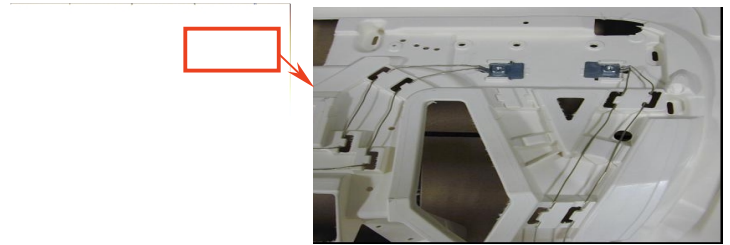
Example: Audi A4 convertible trunk lid, produced by INOPLASTIC OMNIUM:

- Antennas = AM / FM; GPS; GSM; and TV

- Four (4) antenna wires are manually assembled to the trunk lid with a mastic
- The ground plate is bonded



AUDI A4 convertible



Antenna integration

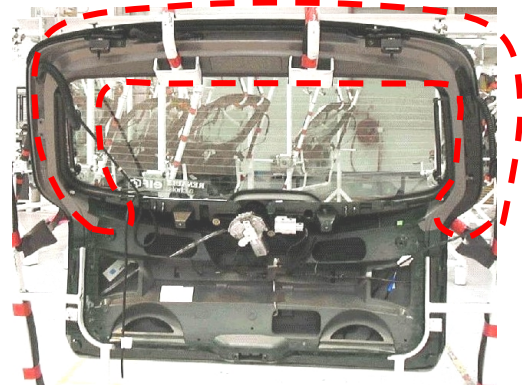
Interior trim integration

Being painted off line, plastic liftgates can have several colors and thus integrate totally or partially the interior trim.

Example: on the RENAULT Laguna Estate, the window pillars trim are integrated in the inner structure. After bonding, inner and outer structures are primed with a colored primer (interior color). Then the inner is partially masked before application of the body color.



RENAULT Laguna Estate



Interior trim integration

Different ways exist in order to integrate the trim:

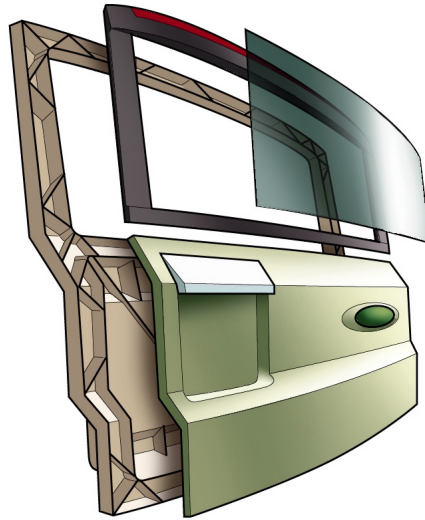
1) Colored primer + mask

This is the solution used for the Laguna Estate. The inner and outer skins are bonded. They are both primed with a colored primer (interior color). Then the area that must have the interior color is masked, before application of the body color on the assembly.

This solution is possible only if the colored primer enables the color matching: the primer cannot be dark if some of the body colors are clear for example.

2) Assembly after painting

The inner and outer skins are painted separately with two different colors: interior and exterior. Then the parts are assembled together, either by bonding or by bolting.



*Example on a 3 parts plastic liftgate, with 3 colors : black / interior color / body color
IPO internal study based on LAND ROVER existing car*

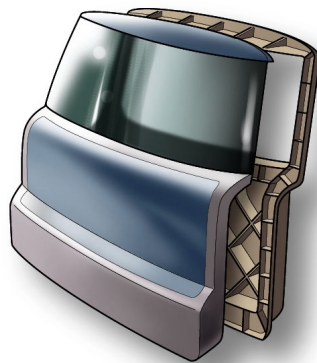
3) Assembly after painting + molded in color material

The assembly is the same as in the previous solution, but using a structural molded in color inner reduces the cost. IPO can propose molded in color SMC or molded in color LGF PP to achieve this target. The part must be grained for appearance reasons.

Exterior cladding integration

The outer skin of the closure is made of plastic material, thus the exterior claddings can be integrated, with their function:

- Collapsible sill for insurance impact test (see next chapter)
- Color diversity, using molded in color TPO for the outer skin + local paint or using film overmolding
- Low speed impact management, can be done by the TPO outer skin which can be molded in color or painted



Outer skin with 2 colors: molded in color + paint

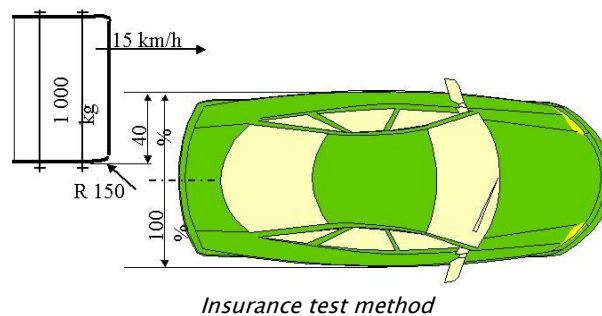
15 KPH INSURANCE REAR IMPACT MANAGEMENT

Description of the problem

Insurance test

A 1000 kg weight vehicle impacts the rear of the car at 15 kph. The cost for the reparation of the car is then calculated, and the target is to have the lowest possible costs. The insurance companies calculate the insurance rates with this test (also performed at the front and side of the vehicle).

If the liftgate is broken during this test, then the reparation costs are very high: the liftgate must be changed, re-painted, and all the accessories (including the window) must be dismantled and re-assembled. The target is to save the liftgate.



Design

In the same time, the styling tendency today is to have a liftgate very flush with the bumper: consequently the liftgate is more often impacted during the test.



Liftgate / bumper flushness

IPO solution: collapsible skin on a plastic liftgate

To allow designers to have a better flushness, and in the mean time reduce the insurance costs, IPO developed a solution consisting in a liftgate made of two main parts:

- The structure, made of SMC materials, is located in the area which is not impacted by the insurance test
- The skin, made of TPO material, is screwed and clipped to the structure and is collapsible at 15 kph.

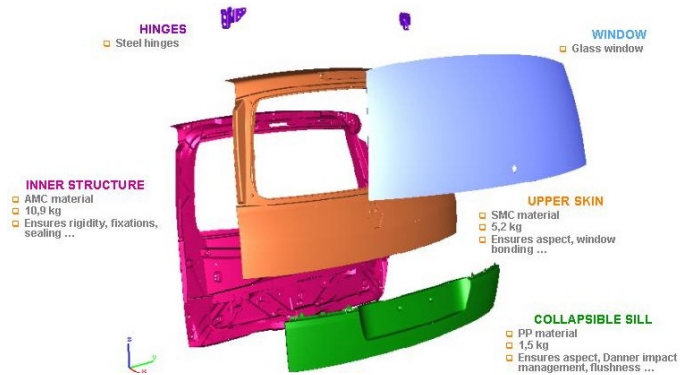
Specific plastic rivets have been studied and developed by IPO: they tear off just before transmitting too much load to the structure. Thus, the skin can be flush with the bumper

and is the only part to be broken during the test.

This solution has been conceived, calculated and validated on the Renault Espace liftgate. It is now in production and provides a solution to the initial specification.



RENAULT Espace liftgate



RENAULT Espace liftgate parts



Rear end vehicle after impact



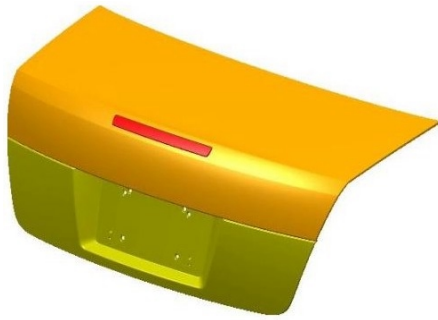
Collapsible plastic rivets

INVESTMENT REDUCTION

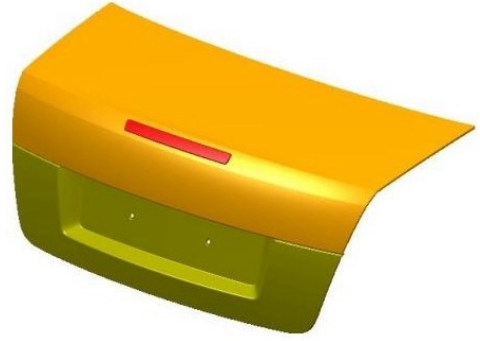
Investment

The investment for a plastic closure fabrication line is much lower than for the same steel closure. The ratio is between two (2) and five (5) depending on the closure geometry. This investments reduction allows the carmaker to restyle more often the vehicle with a reduced cost. It also allows the carmaker to bring styling diversity on the same closure with a reduced cost.

Example: on the AUDI A4 convertible trunk lid there are two different outer skins: one for US market and one for European market. The difference consists in license plate area style.



AUDI A4 convertible - US



AUDI A4 convertible - Europe

Piece price

The investment is reduced, but on the other hand the plastic liftgate can be more expensive than the steel one.

Usually it is admitted that the break point is between 350 veh. / day and 700 veh. / day, depending on the geometry and function integrations:

- Below the break point, it is more advantageous economically to use plastic materials
- After the break point, steel will be more advantageous economically

CARMAKER INDUSTRIAL MANAGEMENT

The use of off-line painted plastic closure can bring industrial advantages to the carmaker:

Reduction of vehicle length during e-coat and paint

Vehicle length reduction is especially worth valuable for vertical closures. More vehicles can then go through paint and e-coat per hour.

Example: RENAULT Espace vehicle



RENAULT Espace liftgate length

Assembly time management

If several vehicles are delivered off line on a same carmaker line, or if there are a lot of

diversity on the same closure, then the diversity that has an influence on the assembly time can be managed by the supplier, who has more flexible lines (smaller).

Assembly ergonomics

The assembly of the liftgate module is easier on jigs than it is when the closure is on the car:

- Accessibility from the rear and the front
- No work with the arms raised
- The jigs can be turned: the access is easier and the height of work can be chosen



Ergonomics



Turned jig



Accessibility (for cables here)

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