

SmooSteel™: an Innovative and Lightweight Steel / Polymer Material for Front Fender Application

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ABSTRACT

The product here presented is a steel-based product developed by ArcelorMittal for weight reduction of vehicles. The driving idea was to combine ease of both steel forming and painting processes, with the polymer small impact compliance by colaminating a thin steel sheet with a polymer film.

SmooSteel™ has been validated for the front fender application, showing weight reductions of 20 to 35% with an attractive weight-saving cost, small impact compliance increased by up to 400%, and being equivalent to monolithic reference in terms of dent resistance, deep drawing, handling, or thermal stability.

INTRODUCTION

The importance of weight savings in the automotive industry no longer needs to be emphasized. For several years now, steel manufacturers have been developing a range of composite products that widen the scope and performance of steel (see for example: (1, 2)).

The development of these steel / polymer composite products has been stimulated by the possibility of combining two factors: reduction in the weight per unit area of a part, while conserving an equal or getting greater functionality, taking advantage of synergies in between the two materials.

Today, weight savings are not limited to structural and inner parts but are also considered for the outer parts which represent 30% of the total body in white mass. For instance, in the case of the front fender which is the first targeted application for the steel / polymer composite described in this article, plastic and aluminium are currently used as an alternative to steel reference.

The colaminated steel / polymer composite will be first described and the example of front fender application will be depicted.

COLAMINATED STEEL / POLYMER CONCEPT AND FIRST TARGETED APPLICATION

COLAMINATED STEEL / POLYMER CONCEPT

In the automotive industry, the use of steel sheet with a thickness below 0.65 mm is very limited beyond functional low performances, simply due to handling and forming difficulties. A steel / polymer composite, with a plastic film from 0.2 to 0.4 mm in thickness, proved to be able to overcome such problems. In fact, the plastic film bonded over the steel surface provides improved elastic properties that makes handling easier, and the thickness increase (0.6 to 0.9 mm in total) with a slightly compressive material gives a more tolerating stamping behaviour.

The material is a two-layer composite consisting of a rigid polymer layer of typically 0.3 mm thickness and one thin Zn-coated steel skin (Figure 1).

The polymer has been specially engineered for high stiffness, heat resistance (for ED-paint baking), adhesion to steel and durability. It is adapted to the functional specifications of the considered parts.

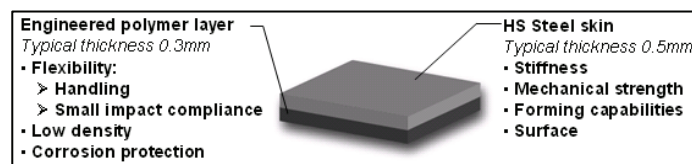


Figure 1: Description of the colaminated steel / polymer composite

FIRST TARGETED APPLICATION

The first targeted application of this colaminated steel / polymer material is the front fender with a 0.5mm HSS (High Strength Steel) and a 0.3mm engineered polymer (Figure 2). In this application, the main competitors are plastic and then aluminium. Compared with monolithic

reference fender of 0.77mm (resp. 0.67mm), a potential weight saving of 30% (resp. 20%) will be observed.



Figure 2: Front fender prototype (partnership with Gestamp)

COLAMINATED PRODUCT IN USE PROPERTIES

THERMAL STABILITY MEASUREMENTS ON A PROTOTYPE AND SIMULATION

Due to thermal expansion differences between steel and plastic, the thermal stability of the stamped colaminated steel / polymer composite has been evaluated.

The thermal stability of the product being questionable at low temperature, measurements on an assembled prototype part have been done at -20°C/-4°F (Figure 2). No geometrical deformations could be measured on the front fender.

Geometrical stability under thermal stresses has been evaluated to ensure constant performances from -40°C/-40°F to 80°C/176°F. Very little geometrical variations have been predicted on the numerical simulation of the thermal stability of the part (Figure 3).

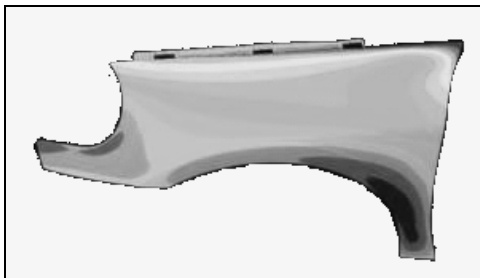


Figure 3: Simulation of geometrical variation under thermal stresses of a front fender part

DENT RESISTANCE

Dent resistance of this material was designed in order to reach the same level of performance than the one currently achieved by conventional front fender solutions

First trials on lab samples (Figure 4)

The colaminated product as previously described, exhibits performances in dent resistance similar (higher resp.) to the ones of a mild steel 0.7mm (0.67mm resp.) monolithic sheet and therefore proves that this material can be used for front fender application (Figure 5). It is

widely known that dent resistance behaviour is linked to the thickness and the yield strength. In the case of the colaminated product, those parameters are increased compared with a 0.67mm mild monolithic steel.

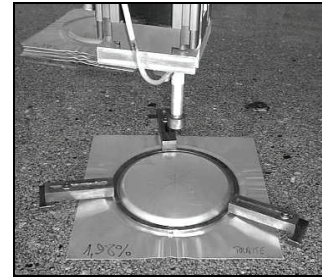


Figure 4: Test performed

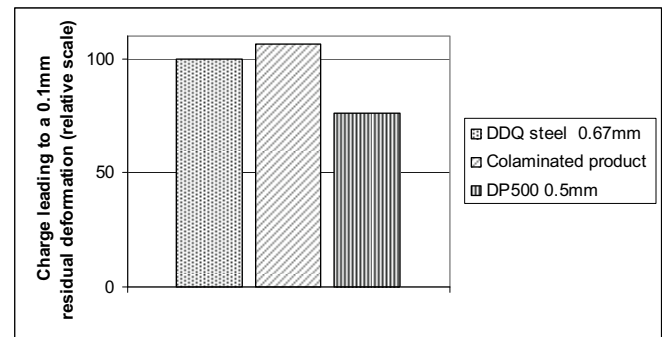


Figure 5: Dent resistance results

Tests on front fender prototypes

A front fender made of mild steel 0.67mm have been compared with the colaminated steel / polymer composite (steel HSS: 0.5mm, polymer: 0.3mm) in terms of dent resistance. The dent resistance is characterized by the force leading to a 0.1mm residual deformation of the part.

The test was made on one point (A, Figure 6) of monolithic and the colaminated steel / polymer composite fender.

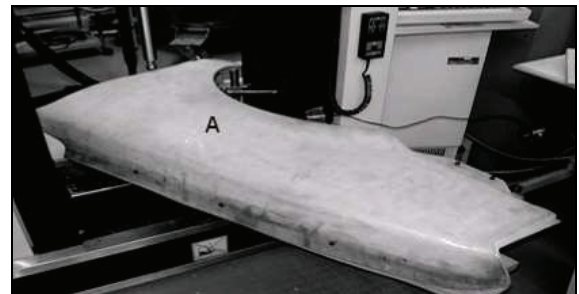


Figure 6: Tested configuration

The results obtained are always better for the colaminated steel / polymer composite than monolithic steel (0.67 mm) (Figure 7). The laboratory results were therefore confirmed on a real part.