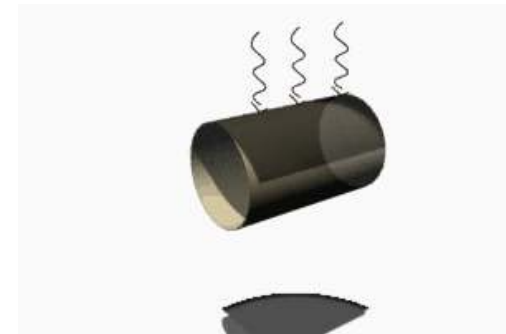


Composite Materials

- *Introduction to composite materials*
- *History of composites in Automobiles*
- *Why Composites ?*
- *Effect of Composites on vehicle – Properties & Performance*
- *Advantages of Composites in Styling & Part Consolidation*
- *Effect on Safety & Crashworthiness*
- *Scope on Modern Auto Industries*
- *Examples of using composites in Modern Auto Industries*
- *Challenges of building a complete composite car*
- *Future*

What is a composite ?

- *A composite material is a homogeneous mixture created by the synthetic assembly of two materials of which one is a reinforcing material called **fiber** and other is the binding material called **matrix**.*



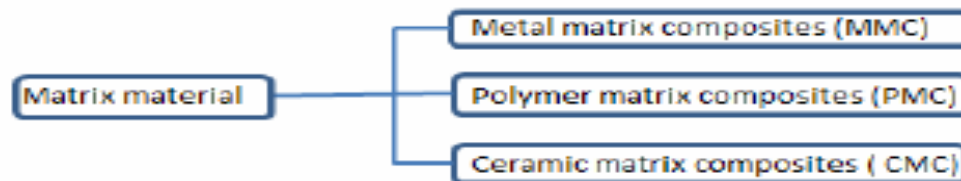
- *It is used in all the fields like Automotive, Aerospace, Construction Industry and Entertainment industry etc*

Characteristics

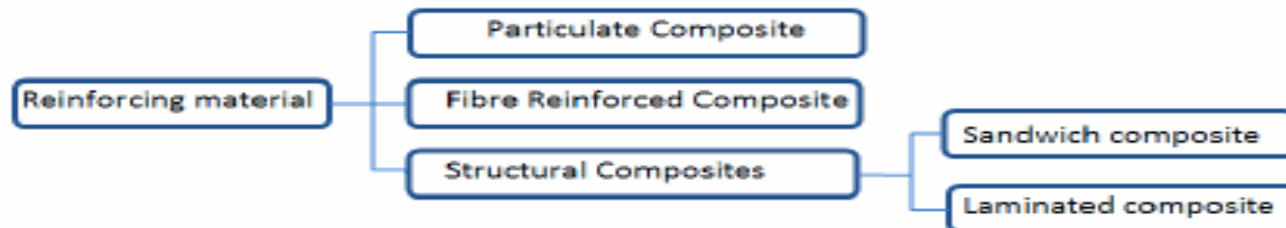
- *Rigid – High Strength to weight ratio*
- *Good Electrical resistance*
- *Resistance to chemical and weather is high*
- *Good stiffness*
- *Good Corrosion resistance*

Classification

Based on Matrix used:



Based on the Reinforcing material used



1930-Henry Ford and his Composite Car



1950-SINGER HUNTER



1954 Singer Hunter - GRP bonnet and side valences (*Source: The American Singer Owners Club*)

1960-Reliant Scimitar



The Reliant Scimitar (GTE SE6a shown here) had a hand laid body supported by a steel chassis *(Source: Nick Tucker)*

1980- Pontiac Fiero



The Pontiac Fiero - mass production composite intensive body (*Source: www.pontiacfiero.com*)

Why Composites ?

- ***To improve the fuel efficiency by reducing the mass***

(Improves straight-line acceleration and top speed, lowering weight offers these benefits as well as improving handling characteristics (especially around curves)).

- ***To improve the safety and crashworthiness***
- ***To enhance styling and part consolidation***
- ***To provide the aerodynamic design***

- increase horsepower or decrease mass. This results in a higher power-to-weight ratio, a key predictor of vehicle performance. While raising horsepower alone improves straight-line acceleration and top speed, lowering weight offers these benefits as well as improving handling characteristics (especially around curves). Less weight also reduces loads on the braking and suspension systems, permitting engineers to take additional weight out of these components.

To improve the fuel efficiency by reducing the mass

- Automobile – 5-7 \$ /KG
- Aeronautical –500- 700 \$ / KG
- Space – 5000 to 7000\$ /KG.

Design/Engine Type	Vehicle Weight (structure and closures)	Fuel Consumption (ltr. per 100 km) and (mpg)	Fuel Efficiency Increase
State of the Art	500 kg	10 (23.5)	0%
A) High strength steel plus structural bonding	350 kg (30%)	9.58 (24.6)	4.20%
B) Carbon fiber composite for structure and closures	270 kg (42%)	9.31 (25.3)	7%
C1) Diesel engine		7 (33.6)	30%
C2) Full Hybrid (Otto)		6.5 (36.2)	35%
C3) Full Hybrid (Diesel)		5.5 (42.8)	45%

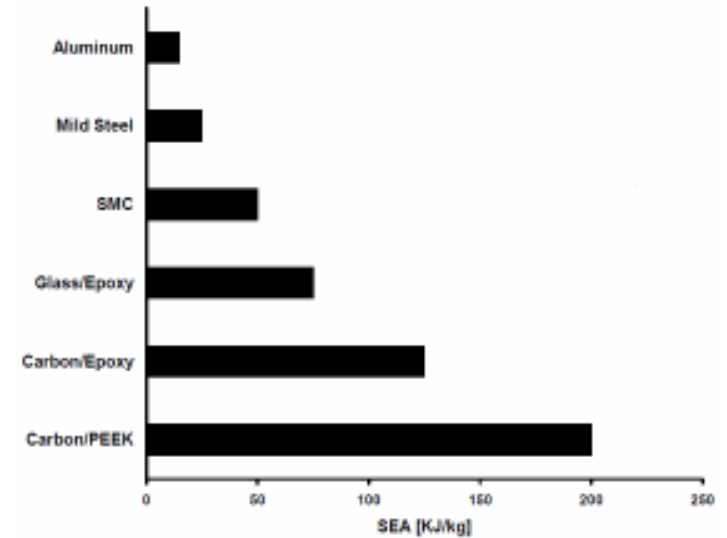
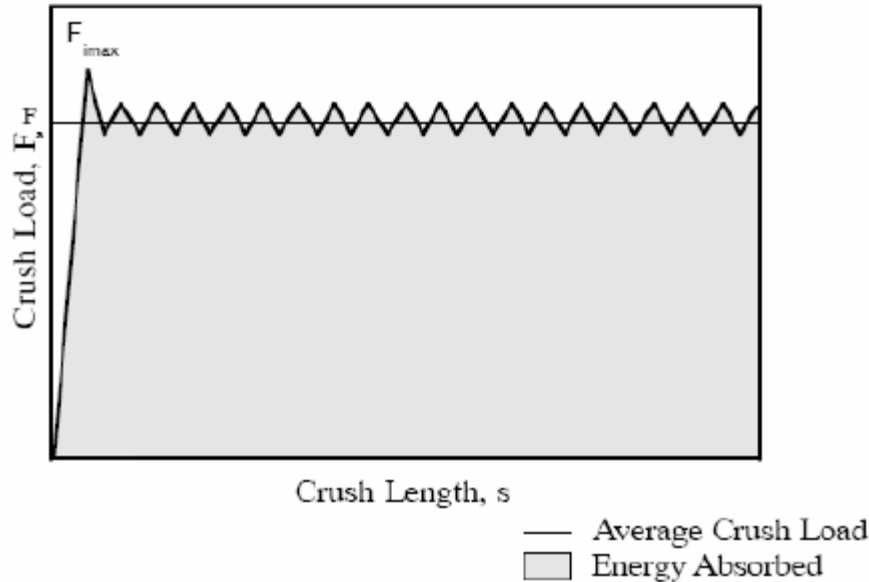
To improve the safety and crashworthiness



- *Maintain occupant survivable volume or occupant space.*
- *Restrain occupants (within that space)*
- *Limit occupants deceleration within tolerable levels*
- *Retain “ safety- cage “integrity*
- *Minimize post crash hazards*

To improve the safety and crashworthiness

Ideal Crush Load vs. Crush Length Curve



The specific energy of absorption is given by
 $S.EA == W / V \rho$

Where W --- Total Energy absorption = Area under curve

V --- Volume of crushed material

ρ --- Density of the material

Safety effect by using composites

- Reduces damage and injury to the passenger from accidents.
- Composite C –fiber composites are preferable over steel/ magnesium or aluminium as they exhibit higher energy absorption values.
- These structure members are in the form of tubular beams and can be made from glass fiber and carbon fiber for more critical components.

To enhance styling and part consolidation



CFRP Inner deck lid for FORD GT

Table 1

Comparison of carbon, glass, and steel unibody design details

	Design 1: carbon fiber	Design 2: glass fiber	Design 3: steel
<i>Design parameters</i>			
Wheelbase (cm)	274.3	274.3	261.6
Length × Width (cm)	472.4 × 180.3	472.4 × 180.3	469.9 × 170.2
Height (cm)	137.2	137.2	144.8
Components	25	25	120
Inserts	37	37	130
<i>Material composition</i>			
Primary material	Two-component polyurethane	Two-component polyurethane	Mild-grade steel
Brand	Bayer AG's Baydur 420	Bayer AG's Baydur 420	Varies
Price (\$/kg)	\$2.65	\$2.65	\$0.77
Reinforcement	Carbon fiber	Glass fiber	NA
Spray price (\$/kg)	\$20	\$2.53	
Lay-up brand	Hexcel Fabric (Woven 24 K)	Owens Corning F2 Matt	
Lay-up price (\$/kg)	\$13.20	\$3.08	
Resin: Reinforcement	65:35 vol%, 50:50 wt%	65:35 vol%, 41:59 wt%	NA
Inserts	Mild-grade steel	Mild-grade steel	Mild-grade steel
Assembly joining	Two-component adhesive	Two-component adhesive	Spot welding
Brand	SIA's Plastilock 731SI	SIA's Plastilock 731SI	NA
Price	\$17.50/kg	\$17.50/kg	NA

Material	Tensile strength	Density	Specific strength
Carbon fibre	3.50	1.75	2.00
Steel	1.30	7.90	0.17



Carbon fibre rear wheel

To enhance styling and part consolidation



LGF PP for POLO front end carrier

SMC (Sheet moulding compound) for GM/ FORD pickup truck (truck box- tail gate)



Glass / Epoxy top sleeper

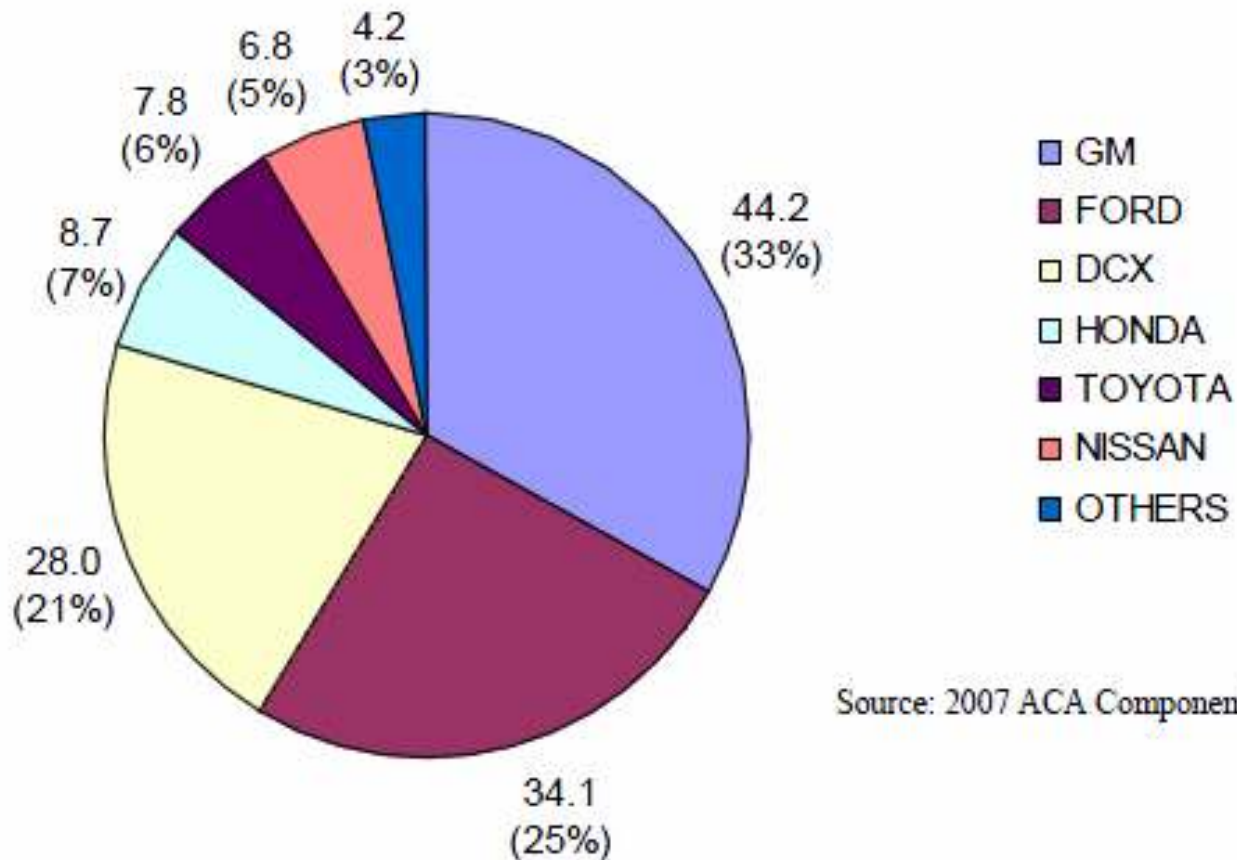


To provide the aerodynamic design

Expended Energy	City	Highway
Tire Resistance	25%	33%
Aerodynamic Drag	18%	51%
Inertia (Linear and Rotational)	57%	16%

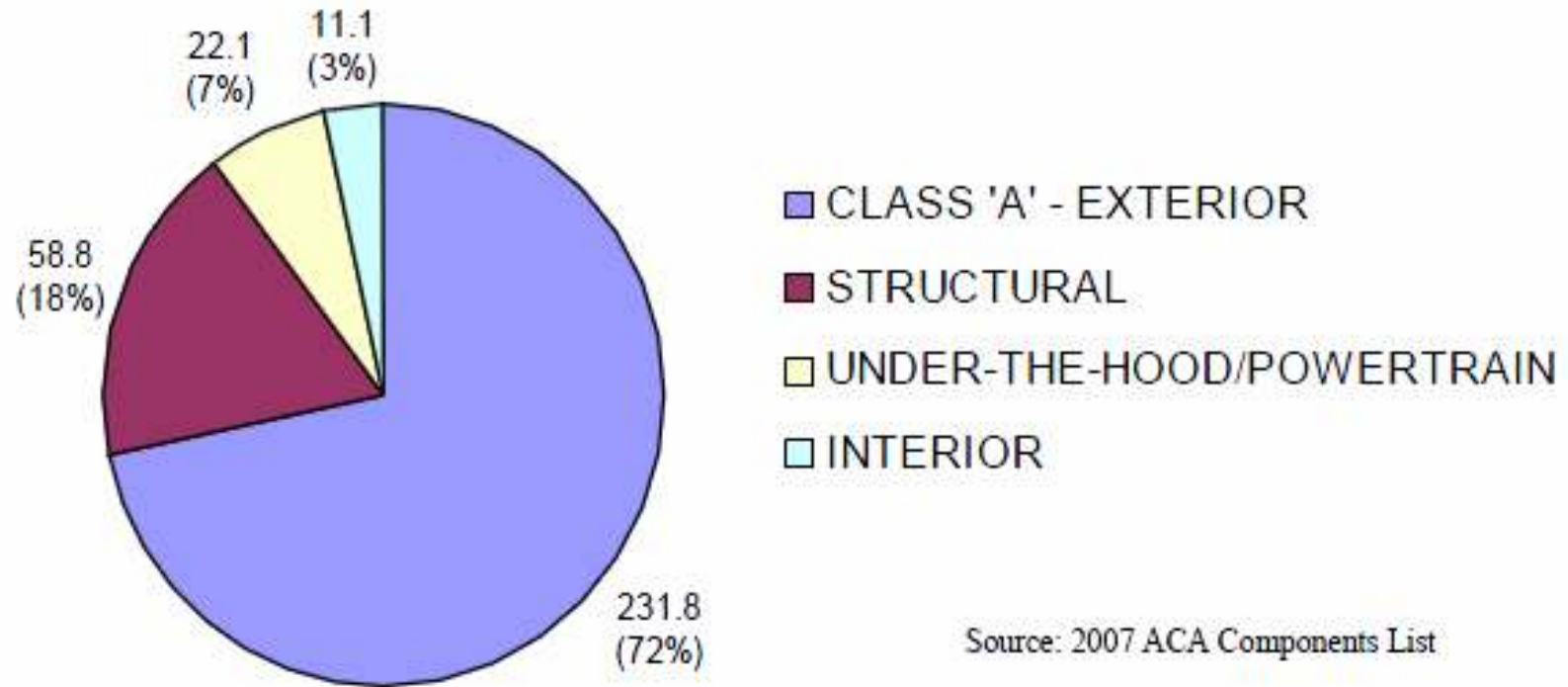
Composites Use Trend

THERMOSET COMPOSITE USE BY OEM LIGHT VEHICLE ONLY - 135 MM LBS.



Source: 2007 ACA Components List

Use by application trend



Citroën XM – a composite front end (*Source: Citroen*)



Ford Focus – Hybrid front end



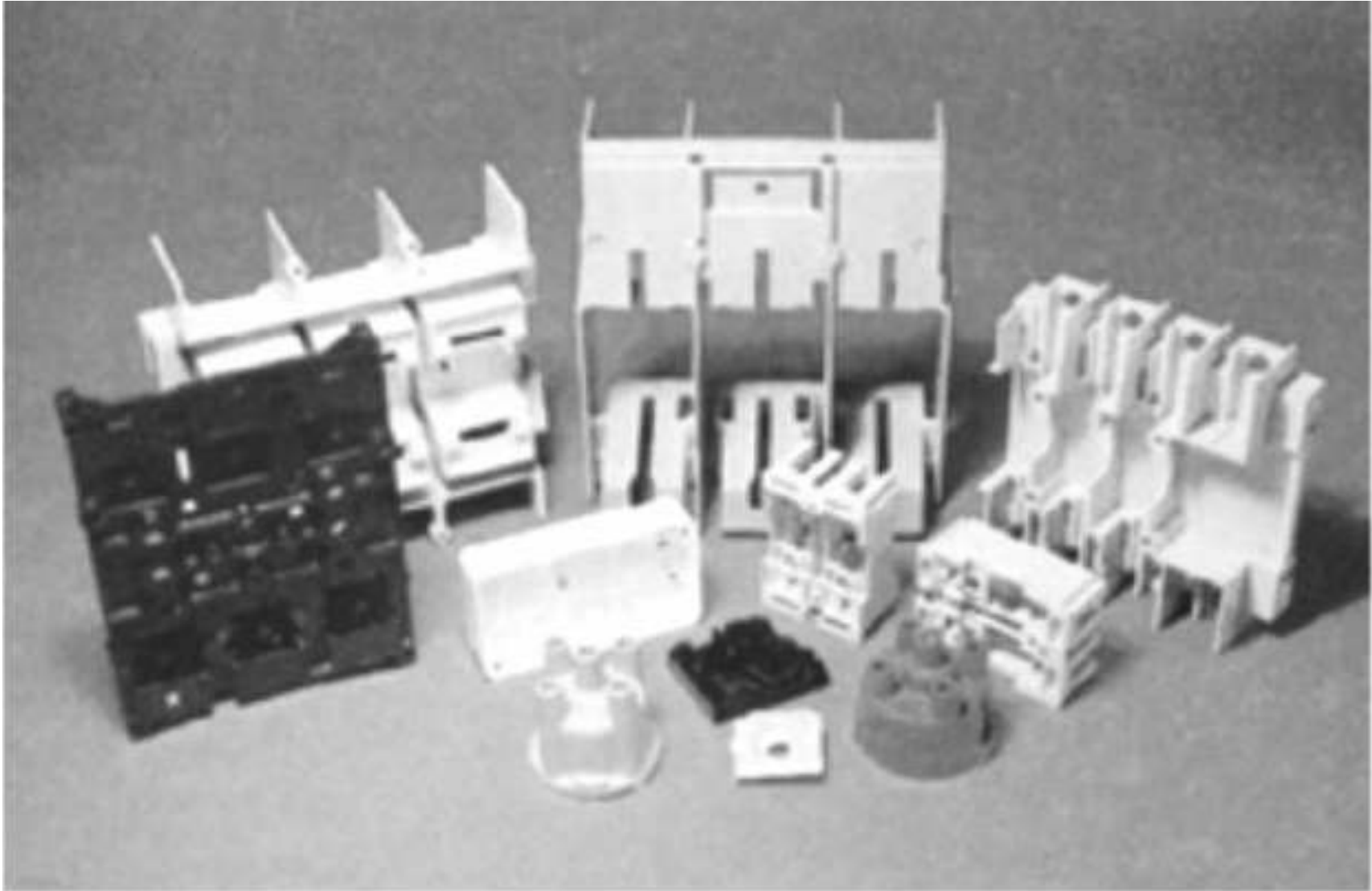
Pontiac Fiero



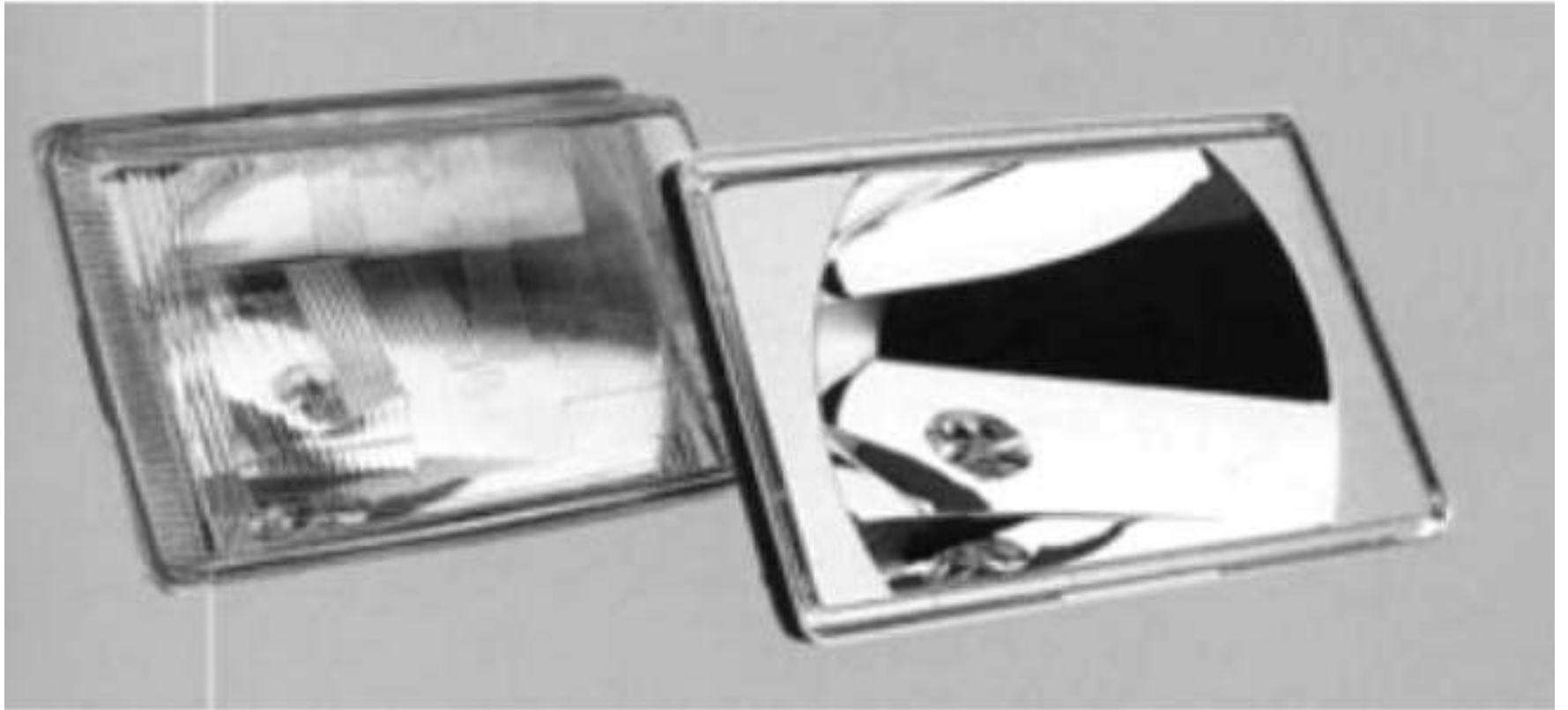
Ford Inlet manifold



DMC Fuse Boxes and distribution caps



Headlamps from DMC



Rolls Royce Cam box



SMC front end moulding for the Ford Taurus
(Source: The Budd Company)



Two-piece SMC windscreen surrounds replaces a multi-part steel pressing (Source: *The Budd Company*)



Chevrolet pickup tailgate by Creative Pultrusion



GMT bumper (*Source: Neil Reynolds*)



Video on Composite material is
used in Sports Car...