Plastics & Composites
Performance : Cost

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Outline

- Introduction
- BASF & Plastics
- What are the main mechanical properties?
- Plastics performance: cost
- Fillers – how they affect properties and cost in PP
- High performance fillers, e.g. glass fibres in PP, nylon and PBT
- Conclusions
BASF is the world’s leading chemical company
87,000 employees
Chemicals, Plastics, Performance Products, Agricultural Products & Nutrition, Oil & Gas
Turnover 33.4 Billion Euros
~26 % of that is Plastics
Plastics are: PS, HIPS, SAN, ABS, ASA, MABS, ABS/PA, SBS, PA6, PA6,6, POM, PBT, PSU, PES, PUR (PE, PP & PVC)
Plastics properties & price
Tensile Testing

- Stress or Force (MPa)
- Strain or elongation (%)

- Brittle failure
- Yield
- Ductile failure
- Increasing temperature
- Lower testing speed
- Plasticiser added
- Break or ultimate
- Energy to break
Modulus : Materials cost

Price of Material (€ / litre)

Modulus (GPa)

- SAN
- PS
- PVC
- PET
- ABS
- ABS POM
- HIPS
- PP-h
- PP-c
- HDPE
- PA6
- PMMA
- POM
- PBT
- PC
- PA6,6
- LDPE

0.50 1.00 1.50 2.00 2.50 3.00 3.50
Strength : Materials cost

Tensile Strength (MPa)

Price of Material (€ / litre)
HDT : Materials cost

Price of Material (€ / litre)

HDT 1.8 MPa (°C)

- HDPE
- LDPE
- PS
- SAN
- ABS
- PET
- PMMA
- PA 6,6
- PA6
- PBT
- HIPS
- PVC
- PP-c
- PP-h
- POM
- PC

BASF
The Chemical Company
Impact: Materials cost

![Graph showing the relationship between Price of Material (€ / litre) and Notched Charpy Impact (kJ/m²) for various materials. The materials include ABS, PC, PMMA, PVC, SAN, PET, PA6, PBT, PP-h, PP-c, HDPE, HIPS, ASA, CAP, MABS, LDPE, PET, ABS/PA. The x-axis represents the Price of Material, ranging from 0.50 to 3.50, while the y-axis represents the Notched Charpy Impact, ranging from 0 to 50.]
Fillers effect on performance
Modulus change with Fillers

- Glass Fibre
- Mineral Fibre
- Mica
- Talc
- CaCO3
- Wood Fibre
- Nanoclay
- Wollastonite

Filler Volume (%) vs. Modulus (GPa)
Strength change with Fillers
HDT change with Fillers

- Glass Fibre
- Mineral Fibre
- Mica
- Talc
- CaCO3
- Wood Fibre
- Wollastonite

Graph showing the relationship between HDT (1.8 MPa) and filler volume (%).
Impact change with Fillers

![Graph showing impact change with filler volume for various fillers such as Glass Fibre, Mineral Fibre, Mica, Talc, CaCO3, Wood Fibre, and Wollastonite.](image-url)
Plastics / composites cost
Composite versus Plastic Modulus & Cost

![Graph showing composite versus plastic modulus and cost](image)

- **SAN**
- **PS**
- **PET**
- **PC**
- **ABS**
- **POM**
- **HIPS**
- **PP-h**
- **HDPE**
- **PP-c**
- **LDPE**
- **PA6**
- **PA6,6**
- **PBT**
- **PMMA**
- **PVC**

**Modulus (GPa)**

- PP GF
- PA6,6 GF
- PBT GF
- PP Chalk
- PP Talc
- PP Mica
- PP Mineral Fibre

**Cost of Material (€ / litre)**

0 0.50 1.00 1.50 2.00 2.50 3.00 3.50 4.00
Composite versus Plastic Tensile yield strength & Cost

- PVC
- PMMA
- PBTPA6,6
- PA6
- PA6,6
- LDPE
- PP-c
- HDPE
- HIPS
- POM
- ABS
- PC
- PET
- SAN
- PS
- PMMA
- PA6
- PA6,6
- PBT

Cost of Material (€ / litre)

Tensile Strength (MPa)

PP GF
PA6,6 GF
PBT GF
Composite versus Plastic
HDT & Cost

![Graph showing Composite versus Plastic HDT & Cost]

- PP GF
- PA6,6 GF
- PBT GF
Composite versus Plastic
Impact resistance & Cost

Notched Charpy Impact (kJ/m²) vs. Cost of Material (€ / litre)

- PP GF
- PA6,6 GF
- PBT GF
Plastics / composites density
Composite versus Plastic Modulus & Density
Composite versus Plastic
Tensile yield strength & Density
Composite versus Plastic
HDT & Density
Composite versus Plastic Impact resistance & Density

<table>
<thead>
<tr>
<th>Material</th>
<th>Notched Charpy Impact (kJ/m²)</th>
<th>Density of Material (kg / litre)</th>
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<tr>
<td>POM</td>
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<td>1.00</td>
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<tr>
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</table>

The diagram shows the relationship between Notched Charpy Impact (kJ/m²) and Density of Material (kg / litre) for various plastic materials.
Conclusions

- Main mechanical properties are modulus, strength, HDT and impact resistance
- Thermoplastics cover a wide range of performance and price
- Filler can be used to alter properties
- Fillers impart properties not attainable in the unfilled plastics
- Fillers give the best balance of performance and materials cost
- Fillers give the best performance for a given weight