11. Tagung
"Problemseminar Deformation und Bruchverhalten von Kunststoffen"

Anforderungen an Polypropylen
im Elektrogerätebereich

The E&E market (Electrical appliances and Electronics) for Polypropylene

Components (including the PP base resins) and properties of Polypropylene Compounds (PCMAs)

Typical requirements for household appliances (application examples)

Development and material trends for appliances

Perspectives and a special surface decoration (PIT) as added values step.

Dr. Thomas Mecklenburg
Basell Polyolefine GmbH / Frankfurt
Europäischer Kunststoffmarkt
West-Europa – Anteile der Produkte

Verbrauch nach Anwendungsgebiet 2005
Gesamtverbrauch 43 Mio. t

- Verpackung
  - Dominierend sind Polyolefine und PET
- Bau
  - PVC führend
- Auto
  - PP führend
  - Restliches Volumen verteilt sich über viele Produkte
- E&E
  - Typisch: Verbrauch verteilt sich über viele Produkte


Quelle: PlasticsEurope Market Research Group, PEMRG
Größte Mengenanteile für Kabelisolierungen
- Dominierend sind hier PVC und PE

Datentechnik dominiert von PC
- Für CD und DVD

In allen übrigen E&E-Segmenten:
- Breiter Einsatz aller Kunststoffsorten
- Für die jeweilige Anwendung ausgewählt nach Leistungsvermögen und Kosten

Quelle: PlasticEurope Market Research Group, PEMRG
Breite Diversifizierung typisch für E&E-Industrie
Innovative Produktentwicklung ohne Kunststoffe nicht mehr denkbar

Struktur der E&E-Industrie
Hoher Diversifizierungsgrad – Vom Computer bis zum Turbinenbau

Die E&E-Industrie umfasst ein breites Spektrum industrieller Produktion
► Nicht nur vom Sicherungskasten bis zum Wäschetrockner
► Auch vom Computer bis zum Turbinenbau

► Ohne den Einsatz von Kunststoffen wären die meisten – alle? – dieser Geräte und Baugruppen nicht zu realisieren
### Anteil von Kunststoffteilen in E&E-Geräten

Durchschnittlich bei 20 Gew.-%:

<table>
<thead>
<tr>
<th>Bereich</th>
<th>Anteil (Gew.-%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Telekommunikation</td>
<td>58</td>
</tr>
<tr>
<td>Haushaltskleingeräte</td>
<td>35</td>
</tr>
<tr>
<td>Braune Ware</td>
<td>26</td>
</tr>
<tr>
<td>Kabel</td>
<td>25</td>
</tr>
<tr>
<td>Haushaltsgrößgeräte</td>
<td>21</td>
</tr>
<tr>
<td>Datenverarbeitung</td>
<td>16</td>
</tr>
<tr>
<td>Bürowürsung</td>
<td>11</td>
</tr>
<tr>
<td>Leiterplatten</td>
<td>7</td>
</tr>
<tr>
<td>Medizinausrüstung</td>
<td>3</td>
</tr>
</tbody>
</table>

- **Hoher Gewichtsanteil von Metall und Beton** (counter weights WMs)

- **Wichtigste Eigenschaft aller Kunststoffe ist ihr elektrisches Isoliervermögen, gepaart mit einfacher Verarbeitung**
  - Führt heute in E&E-Geräten zu einem durchschnittlichen Kunststoffanteil von 20 Gew.-%

- **Schwankt je nach Gerätetyp**
  - Reisewecker: 60 %
  - Röntgenapparat: 3 %

Quelle: PlasticsEurope
Conclusion from this E&E market analysis:

☞ **PP and PCMAs** (= PP compounds) are the most frequently used plastic materials for **household appliances** such as **white goods** and **small appliances** but minor used in other E&E segments.

☞ **Basell** is the leading global supplier of Polyolefin products for the E&E market.
The E&E market (Electrical appliances and Electronics) for Polypropylene

Components (including the PP base resins) and properties of Polypropylene Compounds (PCMAs)

Typical requirements for household appliances (application examples)

Development and material trends for appliances

Perspectives and a special surface decoration (PIT) as added values step.

Dr. Thomas Mecklenburg
Basell Polyolefine GmbH / Frankfurt
What are PCMAs?

PCMAs (Basell’s brands *Hostacom* and *Hifax*) are based on *Polypropylene resins* such as homo PPs, heco’s, raco’s or/and other Polyolefin specialities. The added value of *Hostacom* and *Hifax* products (PCMAs) is generated with a «second» compounding step to integrate:

- **Fillers / reinforcement agents**
  - such as minerals, glass fibers to increase the stiffness
- **Impact modifiers** to modify the stiffness / impact ratio
- **Special additive packages**
  - to enhance the performance such as the life time etc.
- **Pigments** for the color matching.

*PCMAs / definition*
Basell’s Core Businesses as leading Polyolefin supplier

- **Business**: Technology, Advanced Polyolefins, Polyolefins
- **Products**:
  - PCMAs
  - PP-based compounds
  - Catalloy resins
  - Polybutene-1
  - Specialty PE
  - Polypropylene
  - Polyethylene
- **Strategy**:
  - Innovation
  - Performance
  - Customer intimacy
  - Applications: E&E + Automotive
  - Operational efficiency
  - Market leadership
  - Cost leadership

Who is Basell?
Stiffness - Flex. mod. (MPa)

Impact - Ductile/Brittle temperature (°C)

PCMA / base resins

Basell PP Product Families as PP base resins for PCMAas
Basell PP polymerisation technologies

- **Spheripol**: loop(s) + gas phase reactor(s)

- **Spherizone**: multizone reactor + gas phase reactor

- **Novolen**: 2 gas phase reactors
Trends for heterophasic copolymers (heco+)

**Standard hecos:**
- matrix: homopolymer or random
- bipolymer : C2C3

Properties:
- good impact/stiffness balance
- medium-high shrinkage
- not tailored to have excellent aesthetics

**New approaches:**
- Three components Heterophasic copolymers (etc. C2C3C4) with enhanced impact/stiffness balance
- Three components products with enhanced scratch and stress-whitening resistance (low blush), reduced shrinkage.
- Clyrell transparent heterophasic copolymers
- High gloss & very low shrinkage PP < 0.8% (ABS replacement)
- High stiffness & high MFR (Adstif) Heterophasic copolymers
**Classification of inorganic fillers for PCMA**s**

<table>
<thead>
<tr>
<th>Form</th>
<th>sphere</th>
<th>cube</th>
<th>block</th>
<th>plates</th>
<th>needles</th>
<th>fibres</th>
</tr>
</thead>
<tbody>
<tr>
<td>Aspect ratio</td>
<td>1</td>
<td>1</td>
<td>1.4 - 4.0</td>
<td>5 - 100</td>
<td>3-20</td>
<td>&gt;20</td>
</tr>
<tr>
<td>Examples</td>
<td>glass spheres</td>
<td>CaCO₃</td>
<td>Ba-sulphate</td>
<td>talc kaolin (clay) mica graphite</td>
<td>wollastonite gypsum</td>
<td>glass fibres (chopped strand) C-fibres</td>
</tr>
</tbody>
</table>

* The aspect ratio is the ratio of length / "thickness" of the particle*
Reinforcement effect of different fillers

**Stiffness** (Young’s modulus) vs. **filler content**

PCMAs based on homo PP such as **Moplen HF 501N**
Fillers for PCMA

Advantages / Disadvantages

- Increase of **stiffness** (tensile and flexural modulus), especially with glass fibers up to > 10 GPa.
- Increase of **stress at break** especially with glass fibers up to 115 MPa.
- Increase of **HDT**.
- Reduction of **shrinkage** and **CLTE** with increasing filler content.

- Decay of **toughness** and **impact strength** with increasing filler content
- Reduced **surface quality** (flow lines, tiger stripes and less gloss) with increasing filler content.
- Increasing **density** with the filler content.
- More **anisotropic shrinkage**, strong anisotropy and warpage with glass fibres.
Basell *Hostacom* property range (PCMAVs)

- **up to 14,000 MPa**
  - (with 50% short glass fibers)
  - Mostly required property range for white goods

**Properties of PCMAVs**

- **Homo / Copo glass fiber**
- **Homo / talc**
- **Copo / talc**
- **Copo / EPR / talc**
- **Copo**
- **Copo / EPR**
  - No Break

**Charpy Notched Impact Strength at RT (kJ/m²)**

- **HCPP**
- **Catalloy (TPO)**
Effects of Antioxidants on PP / PCMAs

Increase of the LTHA value (oven aging at 130°C) from approx. 1 day to 100 days with only 0,05% of a primary AO.
An efficient AO package is one of the key factors for the life time of PP compounds for E&E applications.

The Arrhenius plot

Abbildung 11: Arrhenius-Auftragung 1/T vs. Ofenstandzeit von 120μm dickem PP; a) ohne Antioxidans, b) mit 0,05% Irganox 1010. [2]

PCMAs / AOs

Autor: Prof. Dr. Samuel Affolter, NTB, CH-9471 Buchs, Schweiz
Anforderungen an Polypropylen im Elektrogerätebereich

1. The E&E market (Electrical appliances and Electronics) for Polypropylene
2. Components (including the PP base resins) and properties of Polypropylene Compounds (PCMAs)
3. Typical requirements for household appliances (application examples)
4. Development and material trends for appliances
5. Perspectives and a special surface decoration (PIT) as added values step.

Dr. Thomas Mecklenburg
Basell Polyolefine GmbH / Frankfurt
Very specific and challenging requirements for E&E main applications (such as white goods and small appliances) which are usually not existing for example for Automotive applications.

1. Molded parts which are exposed to hot water, steam, detergents, bleach etc.

2. Visible parts with a wide surface area in white or bright colors with a high level of esthetical requirements.
E&E applications – specific requirements (1)

Molded PP parts which are exposed to hot water, steam, detergents, bleach etc.

... specific for washing machine tubs, laundry and dishwashing equipment but also valid for some small appliances.

What can be the impact of these exposures?

- Extraction of additives (especially AOs) and reduced life time
- Discoloration / staining of white or bright coloured parts
- Decay of mechanical properties (stiffness, impact properties)

High extraction stability and low discoloration under exposure are the typical features of special „hot water additive packages“.
Visible parts with a wide surface area in white or bright colors with a high level of esthetical requirements

… specific for exterior / well visible parts of white goods (e.g. laundry dryer doors, top loader WM frames, panels) and for housings of small appliances.

What is the critical factor and risk?

Visible (dark) impurities on molded parts are usually not accepted for the assembling of the appliances (accepted scrap rate < 2-3%)

There are multiple potential sources for impurities in PCMAs from the used raw materials until the compounding process including the logistic chain (shipping of pellets to the molders).

The production of „white“ and critical PCMAs requires dedicated compounding lines with special cleaning procedures.
These typical features

1. Molded parts which are exposed to hot water etc.
2. Visible parts with a high level of esthetical requirements.

requires

a classification of the E&E applications by technical requirements into

4 different classes or types of applications
Technical Classification by requirements

Visible parts with exposure to hot water, steam and detergents
Low discoloration / staining and high extraction resistance of the additives are the first priorities.

DW cutlery baskets
after dishwasher life time test

Kettle
inner side after longer term use

Examples for less suitable PP products with a „standard“ AO package – **strong discoloration** with hot water
Typical dishwasher construction:

Most of the interior parts are visible with „class 1“ requirements
Technical Classification by requirements

Not visible parts with exposure to hot water, steam, detergents. Mechanical performance and good extraction resistance (lifetime) are the priorities; color and discoloration are less important.

Washer (front loader) tub
Washer (front loader) tub - details
Effiziente Konstruktion reduziert den Wasserverbrauch pro Waschvorgang um 2 Liter

Einsparpotential:
- 6 Mrd. Liter Wasser
- 300 Mio. kWh Elektrizität
- Beispielrechnung für Deutschland mit 35 Mio. Haushalten

Konstruktion nur mit Kunststoffen möglich
- PP verstärkt
Technical Classification by requirements

Visible parts without hot water and detergent exposure but high esthetical requirements.

High surface quality without black specks and the color matching are the priorities.

 WM Pedestal

Refrigerator drawer

Electr. toothbrush

Classification
Anwendungsbeispiele in Hausgeräten
Staubsauger – Kühlschränke

- Kunststoffe umgeben unser tägliches Leben
- Beispielsweise in vielen elektrisch betriebenen Haushaltsgeräten
  - Staubsaugergehäuse aus PP
  - Kühlschrank mit Bauteilen aus PS, ABS und EPS
Technical Classification by requirements

4. **Not visible** parts without water and detergent exposure
   Mostly only mechanical performance required but “cold shipping test” is more and more used also in Europe

*Structural parts* of Dishwasher and Laundry dryers

*But this part (door frame) is visible and exposed to steam (see class 1)*
The applications under class 1 and 2 are the purpose for special long term immersion tests to comply with the special requirements for critical white goods parts.

- **Hot water**: demineralised water at 95°C / usual testing period 1000 h.
- **Laundry detergents**:  
  *Customer specification*: 1% Persil with bleach at 95°C / usual testing period up to 2000h. 
  *UL 2157*: 2.5% Tide without bleach at 82°C / 138 d.
- **Dishwasher cleaning agents**:  
  *Customer specification*: 1% Somat at 75°C / usual testing period 40 days.
- **Dishwasher rinsing agents**:  
  *Customer specification*: 0.3% Somat at 75°C / usual testing period 40 days.
- **Olive oil**:  
  *Customer specification*: Water + Olive oil (200:1) at 75°C / usual testing period 21 days.

**Monitoring of properties** (vs. reference before exposure)

- **Discoloration** da, db, dL and dE
- **Mechanical properties** (tensile stress / strain and unnotched impact strength)
- **Stabiliser extraction** = LTHA (150°C hot air) values before / after immersion.

*Immersion testing*
Discoloration: … one example for a product which was **not** designed for hot water exposure

Immersion testing
**Mechanical properties:** Decay of Charpy unnotched impact strength over hot water immersion at 95°C for 25% GF reinforced PP products Me 36/06 / HCL DP206/01-09

**Graph:**
- **Y-axis:** Charpy unnotched impact strength at RT (kJ/m²)
- **X-axis:** Immersion time (days)
- **Legend:**
  - /01=homo PP im
  - /03=homo PPN
  - /04=homo PP add
  - /09=homo PP w/o CA

**Notes:**
- Improvements of coupling and hot water resistance with special “additives”
- Immersion testing
- **Observations:**
  - > 50% decay
  - homo PP based product (03) don’t comply with UL 2157
Why are the mechanical properties over detergent and hot water exposure and improvements important especially for glass fiber reinforced PCMAs?

This is one part of the UL requirements and standards for household appliances.
As one example: **UL 2157 standard for Laundry machines**

**Required test program for plastic materials**

**Test conditions:**

1. for a part subjected to wash water, 30 specimens (10 for each period) shall be immersed for 30, 60, and **138 days at 82°C** in **2.5% (by weight), aqueous laundry detergent solution**

2. for a part subjected to laundry bleach, 10 specimens shall be immersed for **1000 h at 100°C in 100% bleach**; and

3. The laundry detergent and bleach solution shall consist of 50 g of non-concentrated powdered laundry detergent and 100 ml of bleach per litre of water.

Upon comparison to unconditioned specimens, **50% retention** of the **tensile strength** (ASTM D 638) and of the **tensile impact energy** (ASTM D 1822) is required for all exposures.
Mineral filled PCMA\text{s} don't have the problem with the decay of the mechanical properties over hot water immersion because a filler / PP-matrix coupling is not used.

On the other hand the level of mechanical properties (stiffness and impact strength) of mineral filled PCMAs is on a much lower level.
The compliance with the **UL 2157** today is a **global requirement** and a must for plastic parts (exposed to detergents, hot water etc.) used in washing machines.

**Glass fiber reinforced PCMAs** are required especially for high spin speed washer (> 1200 rpm) because of the high forces generated due to unbalance loads for **washing machine tubs**.
Anforderungen an Polypropylen im Elektrogerätebereich

1. The E&E market (Electrical appliances and Electronics) for Polypropylene
2. Components (including the PP base resins) and properties of Polypropylene Compounds (PCMAs)
3. Typical requirements for household appliances (application examples)
4. Development and material trends for appliances
5. Perspectives and a special surface decoration (PIT) as added values step.

Dr. Thomas Mecklenburg
Basell Polyolefine GmbH / Frankfurt
PCMAs are not only of interest for the classical applications (white goods and small appliances) but also for other appliances such as

- Powertools
- Outdoor applications (e.g. lawn movers)
- HVAC (heating, ventilation, air conditioning)
- Water / heating pumps etc.

Today for these applications / housings are often are used Polyamid 6 (GF reinforced) and ABS – depending from the requirements.

*PP compounds are competitive concerning the costs as well as the technical performance for these applications.*

Applications
... examples for PP and PCMA applications for power tools
Current E&E development trends are …

1. **ABS replacement** (as drop-in solution on ABS tools)

   Required are PCMAs with an ABS properties profile:
   - low shrinkage < 0,7%
   - high impact strength
   - tensile E modulus > 1800 MPa
   - good scratch resistance

2. **Polyamide 6 -GF** (and other engineering plastics) replacement

   Required are GF reinforced PCMAs with:
   - high stiffness (tensile E modulus > 7000 MPa)
   - high impact strength (Charpy notched impact > 12 kJ/m²)
   - good chemical resistance and LTHA properties.
ABS replacement

In principle the **shrinkage** of semicrystalline PP resins is far above that of ABS: >1,2 vs. < 0,7% (depending from the injection molding conditions).

With new polymerisation technologies and catalyst systems have been developed new PP base resins (heco’s) with a shrink of < 0,9% and an excellent stiffness/impact ratio.

**Based on these heco’s PCMAs are feasible which can match the ABS property profile** (with major advantages but also some limitations).

**Datasheet comparison**

<table>
<thead>
<tr>
<th>ABS grade</th>
<th>Hostacom TKC 234D</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Charpy notched impact (23°C):</strong></td>
<td><strong>Charpy notched impact (23°C):</strong></td>
</tr>
<tr>
<td>38 kJ/m²</td>
<td>&gt; 40 kJ/m²</td>
</tr>
<tr>
<td><strong>Tensile E modulus:</strong></td>
<td><strong>Tensile E modulus:</strong></td>
</tr>
<tr>
<td>1900 MPa</td>
<td>1800 MPa</td>
</tr>
<tr>
<td><strong>Shrinkage:</strong></td>
<td><strong>Shrinkage:</strong></td>
</tr>
<tr>
<td>0,5 – 0,7 %</td>
<td>0,6 – 0,8 %</td>
</tr>
<tr>
<td><strong>Density:</strong></td>
<td><strong>Density:</strong></td>
</tr>
<tr>
<td>1,02 g/cm³</td>
<td>1,11 g/cm³</td>
</tr>
<tr>
<td><strong>HDT B:</strong></td>
<td><strong>HDT B:</strong></td>
</tr>
<tr>
<td>101 °C</td>
<td>98 °C</td>
</tr>
</tbody>
</table>

ABS replacement
ABS Replacement: Lawn mover parts / housings

HC TKC 234D G72500 commercial product which did replace ABS (as drop in solution on ABS tools) !!
ABS/HIPS Replacement: Refrigerator Guards

There must be distinguished

ABS replacement as drop in solution or ABS replacement with new tools
PA-GF replacement

Based on special PP base resins with an optimised coupling today short glass fiber reinforced PCMs (based on GF chopped strands) are feasible which can match mostly the PA6-GF30 property profile (with major technical advantages concerning water absorption but also limitations concerning melting temperature / HDT).

Datasheet comparison

**PA6-GF30**

<table>
<thead>
<tr>
<th>Property</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Charpy notched impact</td>
<td>15 / 30 kJ/m² (dry/cond)</td>
</tr>
<tr>
<td>Tensile E modulus</td>
<td>9500 / 6200 MPa (dry/cond)</td>
</tr>
<tr>
<td>T stress at break</td>
<td>115 MPa (cond)</td>
</tr>
<tr>
<td>Shrinkage</td>
<td>0.35 %</td>
</tr>
<tr>
<td>Density</td>
<td>1.36 g/cm³</td>
</tr>
<tr>
<td>HDT B</td>
<td>220 °C</td>
</tr>
</tbody>
</table>

**Hostacom EKG 295L** *(PP-GF40)*

<table>
<thead>
<tr>
<th>Property</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Charpy notched impact</td>
<td>14 kJ/m²</td>
</tr>
<tr>
<td>Tensile E modulus</td>
<td>8000 MPa</td>
</tr>
<tr>
<td>T stress at break</td>
<td>95 MPa</td>
</tr>
<tr>
<td>Shrinkage</td>
<td>0.2 – 0.9 %</td>
</tr>
<tr>
<td>Density</td>
<td>1.26 g/cm³</td>
</tr>
<tr>
<td>HDT B</td>
<td>158 °C</td>
</tr>
</tbody>
</table>

PA-GF replacement
A stiffness / impact ratio which can be achieved with PP data series of GF PP composites

- 40% GF Reference is with Moplen homo PP
- Glass fibre loading: 45 - 65%

PA-GF and steel replacement
Anwendungsbeispiele in der Elektrotechnik
Stecker, Steckerleisten, Elektroverteiler und Sicherungskästen

- In vielen Bereichen der Elektro-, IT- und Hausgeräteindustrie kommen flammgeschützte Kunststoffe zum Einsatz
  - Zusatzforderungen:
    - Hohe Wärmeformbeständigkeit
    - Häufig auch UV-Beständigkeit
    - Gute Fließfähigkeit

- Moderne Produktformulierungen erfüllen diese Anforderungen
  - Beispiel: Bauteile aus PC
Steel replacement: Chassis-Comp of refrigerators

PA-GF and steel replacement

Steel Chassis-Comp

PP (Glass fiber, Supporting bar) 1st, 2nd trial test sample
Anforderungen an Polypropylen im Elektrogerätebereich

1. The E&E market (Electrical appliances and Electronics) for Polypropylene
2. Components (including the PP base resins) and properties of Polypropylene Compounds (PCMA)
3. Typical requirements for household appliances (application examples)
4. Development and material trends for appliances
5. Perspectives and a special surface decoration (PIT) as added values step.

Dr. Thomas Mecklenburg
Basell Polyolefine GmbH / Frankfurt
Perspectives

Today Polyolefines and PCMAs are preferred plastic materials for household appliances.

➡️ In future a cumulative replacement of engineering plastics (PA, PBT, PC etc.) with high performance PCMAs can be expected especially for applications where the higher thermal resistance of engineering plastics is not required.

.sax One of the reasons for this continuous replacement is the permanent innovation push of Polyolefines.
Plastics Interface Technology (PIT)

*added value with a one step surface decoration process* to overcome weaknesses of PP

Overlay
Decor
Tie Layer
Polypropylene
Backin

PIT - Process

*Processing of the „plastic“ core layer can be Injection molding, Co-Extrusion, Compression*

The thickness of the Duroplast-Metal sheet is variable.
( ~ 0,10 - 2,0 mm )
Improvements of PP based finished parts with PIT

- High scratch resistance through surface
- Chemical resistance / UV resistance
- Stiffness / HDT / Heat Reflection
- Flammability resistance / UL94 - V0
- Dimensional Stability / 3 - D
- EMI shielding / Electrical , magnetic properties
- Surface structure and decoration
- Recycling
Mechanical property testing of Laminates

Product: Hostacom M2 U01 without and with PIT

Flexural Modulus
MPa ISO 178

- 23°C
- 60°C
- 90°C

HC M2 U01 0,2 mm Decor 0,2 mm Aluminium 0,2 mm Steel
Possible applications of PIT in the E&E segment

**White goods:**
- e.g. Base plate with Functions,
- Door for Dishwasher,
- Dish washer tub,
- EMI Shielding of motors (USA)

**Small appliances:**
- e.g. Toaster (inner Reflection, outer Decor)
- Espresso machine (Metal design)
- Vacuum cleaner housing (Stiffness)

**Other appliances:**
- e.g. Monitor (EMI-Shielding; UL94 V0)
- Lamps (Reflection)
Trademarks / Disclaimer

- Catalloy, Moplen, Pro-fax, Metocene, Adstif, Clyrell, Pro-fax Ultra, Lupolen, Lupolex, Luflexen, Lucalen, Hostalen, Adflex, Adsyl, Hifax, Hostacom, Hostalen PP, Softell, Spheripol, Lupotech T, Lupotech G, Spherilene, Spherizone and Avant are trademarks owned or used by Basell.

- Moplen, Pro-fax, Adstif, Lupolen, Luflexen, Lucalen, Hostalen, Adflex, Adsyl, Hifax, Hostacom and Spherilene are registered in the U.S. Patent and Trademark Office.

Disclaimer:
Before using a Basell product, customers and other users should make their own independent determination that the product is suitable for the intended use. They should also ensure that they can use the Basell product safely and legally. (Material Safety Data Sheets are available from Basell at www.basell.com). This document does not constitute a warranty, express or implied, including a warranty of merchantability or fitness for a particular purpose. No one is authorized to make such warranties or assume any liabilities on behalf of Basell except in writing signed by an authorized Basell employee. Unless otherwise agreed in writing, the exclusive remedy for all claims is replacement of the product or refund of the purchase price at Basell's option, and in no event shall Basell be liable for special, consequential, incidental, punitive, or exemplary damages.