









GRAFT POLYMER
COMBINE INCOMPATIBLE

Company Business Units

-  FUNCTIONAL MODIFIERS & POWDERS
-  POLYMER ALLOYS
-  CROSSLINKING SOLUTIONS
-  SYNTHESIS
-  POROUS
-  R&D



Novel Solution

Using our own
proprietary
technology

POLYMER ALLOYS - GRAFTAMID™ NANOSTRUCTURED COPOLYMERS

Bring flexibility and good thermo-mechanical properties to your materials with **GRAFTAMID™**.

With **GRAFTAMID™** we combine separate material's best properties with co-continuous nano morphology. Enhance your existing materials or use it as a standalone material for chemical resistance and good barrier properties.

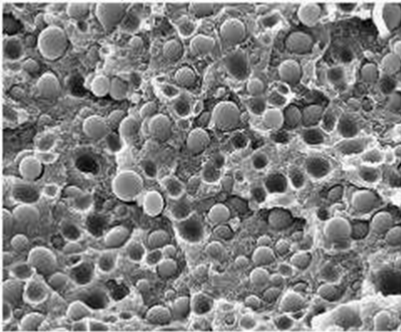


GRAFT POLYMER
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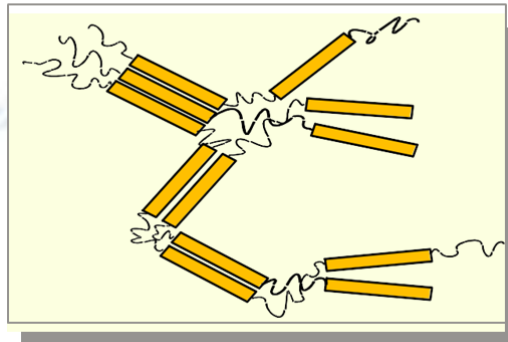
Nanostructured copolymers

Thermoplastic elastomers TPE

Classical TPV

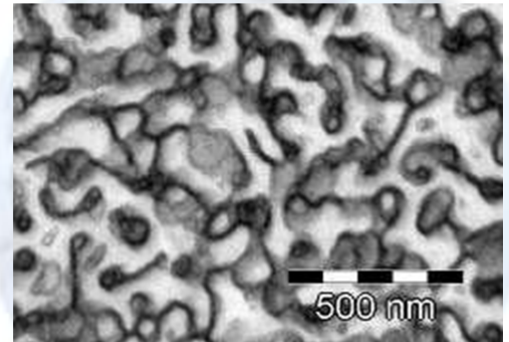


Block copolymers



 Rigid segment
 Soft segment

Grafted copolymers Graftamid



- TP continuous phase (PP)
- Crosslinked discontinuous soft phase (EPDM)
- Microscale

- Block copolymers
- Possible inherent nanoscale morphology

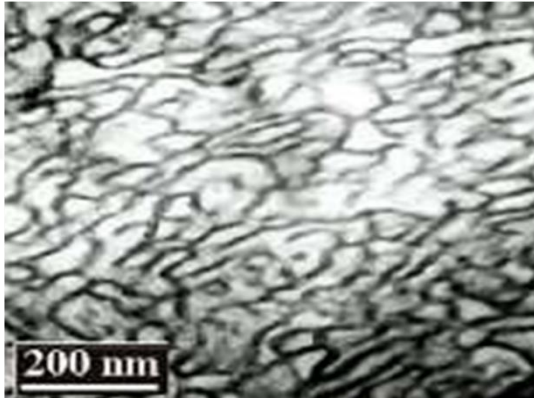
Generally, one phase is soft (low T_g , low E-modulus) or hydrophilic, While other phase is rigid (high modulus)

Graftamid™ – Grafted copolymers

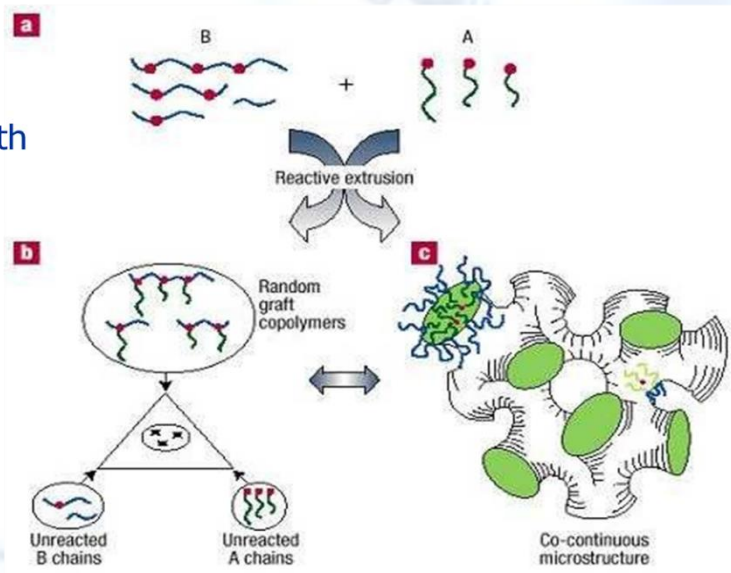
Graftamid® grafted copolymers :

Copolyolefin main linear chain, with grafted linear lateral chain

Co-continuous morphology



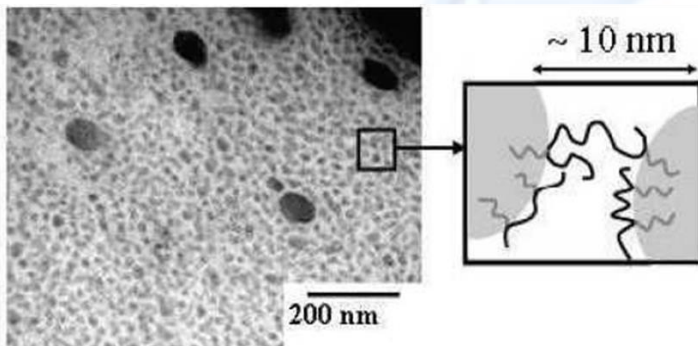
Graftamid®



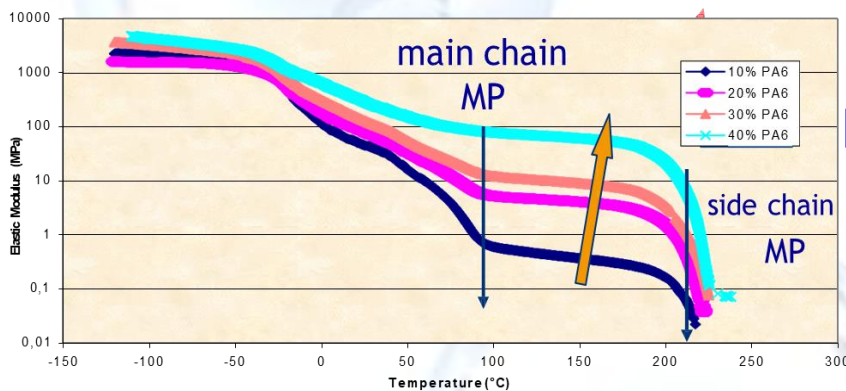
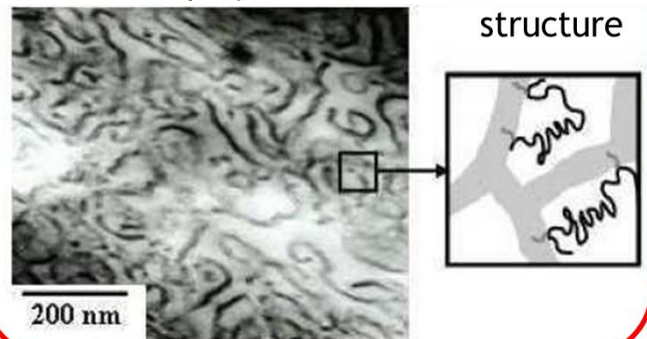
Reactive extrusion grafting

Proper choice of chemistry & process leads to co-continuous structure
Thermoplastic processability

Grafted copolymer with micellar structure



Grafted copolymer with co-continuous structure



Co-continuous structure for thermo-mechanical resistance of Graftamid®

MAIN ADVANTAGES

- *Transparency*
- *Processability*
- *Thermo-mechanical and oxidation resistance*
- *Chemical resistance*
- *Compatibility with polyolefins (and polyamids)*

GRAFTAMID™ - Main Products Range

EB-PA 01506

EB-PA 01566

EB-PA 02046

EB-PA 02012

GRAFTAMID EB-PA 02046	285° C	PA 46
GRAFTAMID EB-PA 01566	250° C	PA 66
GRAFTAMID EB-PA 01506	210° C	PA 6
GRAFTAMID EB-PA 02012	170° C	PA 12

GRAFTAMID™ EB-PA - is based on EBA matrix, and polyamide 6/ 66/ 46 and 12, with increased thermo-mechanical properties. Offers good barrier properties, chemical resistance, low moisture uptake and easy processing. Can be used as compatibilizer for PA blends/compounds or as a standalone materia.

Special products:

Additives may be introduced during grafting process

- **Fire retarded grades** (HFFR with UL 94 V0 or V2 ranking, brominated FR with high thermal resistance)
- **PEG grafted PO** (with high water permeation rate and high water uptake)
- Tailor-made grades possible

Wide range of melt flow index available:

- possible extrusion (blow/cast/calendar), injection / injection blow moulding...

GRAFTAMID™ - Possible Applications

Graftamid in automotive

- Thermal protection for cable, multilayers...

Graftamid in special films

- Transparency and adhesion in photovoltaic films,
- Thermo-mechanical and adhesion in multilayers adhesive films

Fire retarded Graftamid grades

- Cable, corrugated tubings for fire and thermal protection

Graftamid as an additive

- Thermo-mechanical and adhesion in polyolefins or TPV's,
- Impact strength in polyamids
- Hot melt adhesives

GRAFTAMID™ Applications in automotive

Automotive :

- Thermal protection for tubing, cables
 - T4 (3000h @ 150° C)
 - Graftamid® homologated in automotive cables



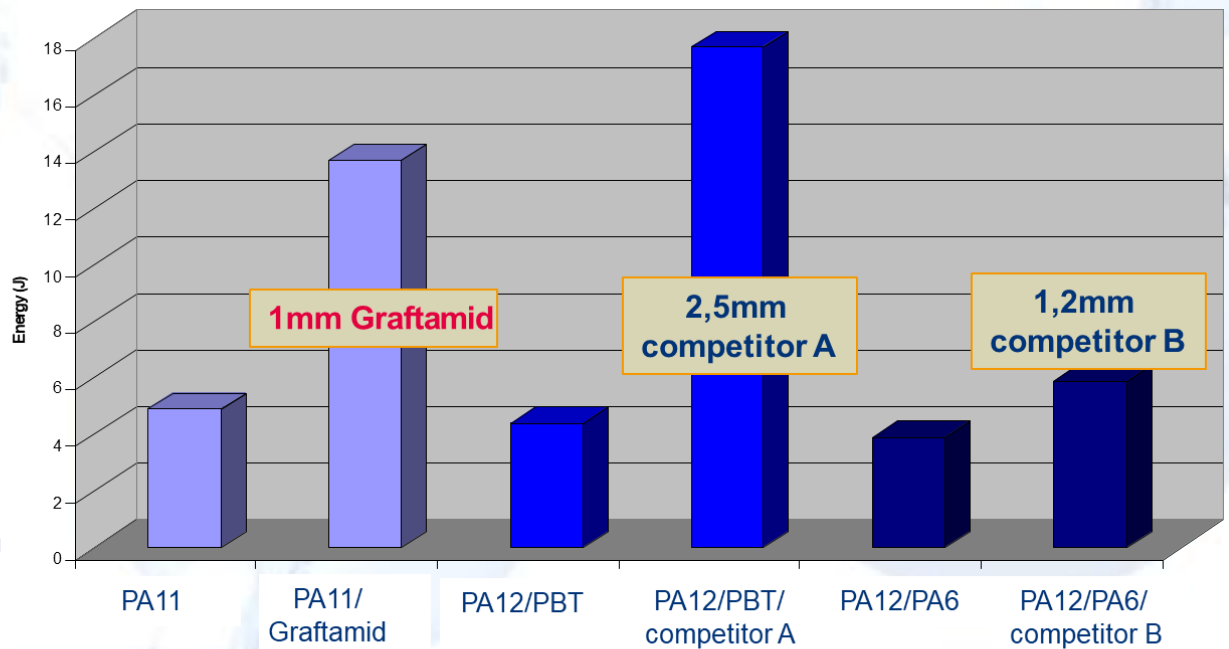
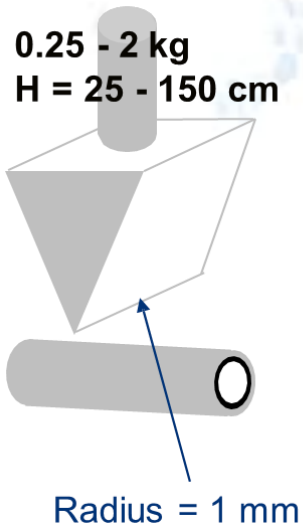
Graftamid® performances :

- heat ageing & impact performances
- hydrolysis, oil and ZnCl₂ resistance
- easier processing than traditional TPV (coex versus 2-step process)
- can often be used at lower thickness (i.e. 1 mm versus + 1.5 mm)
- can be used in multilayer structures with PA without tie layer



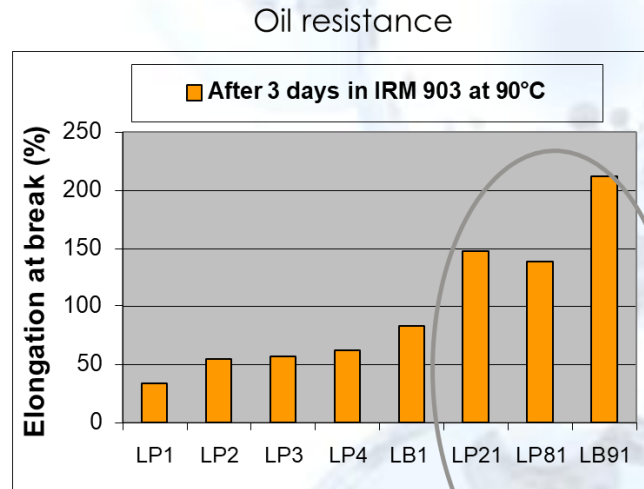
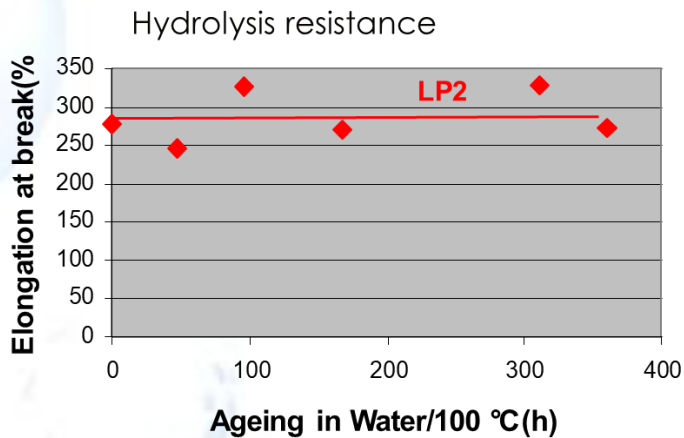
GRAFTAMID™ - Impact resistance

«Guillotine » impact test (RSA D42 1235)



Determination of maximum impact energy to break a tube

GRAFTAMID - chemical & ageing resistance



Excellent ageing resistance in

- Water at 100° C
- Water/glycol mixture at 130° C
- ZnCl₂ aqueous solution at room temperature

Good resistance to occasional oil contact for all grades.

AUTOMOTIVE : thermal protection layer

High temperature heat shield cover

Protection from thermal and hydrolytic attack:

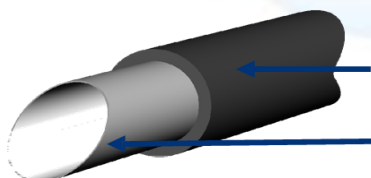
- Graftamid little affected by heat ageing
- Graftamid shows water/glycol oil / ZnCl₂ resistance
- Graftamid adheres to and protects polyamide
- Easy thermoforming
- HFFR versions available

Application examples (automotive)

- Outer protective layer (Fuel lines)
- Outer / inner protective layer (Cooling lines)



thermoformed tubing



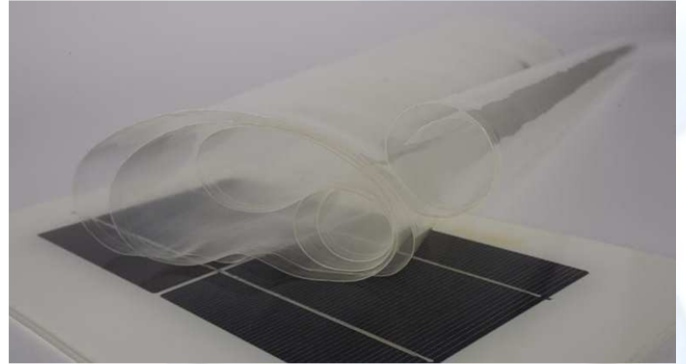
Application	Fuel lines	Cooling lines
Outer Layer	Graftamid	Graftamid or PA12
Inner Layer	PA12	PA12 or Graftamid



GRAFTAMID - for special films

Photovoltaic films

- Encapsulation of PV modules (flexible panels, CIGS modules...)



Special films

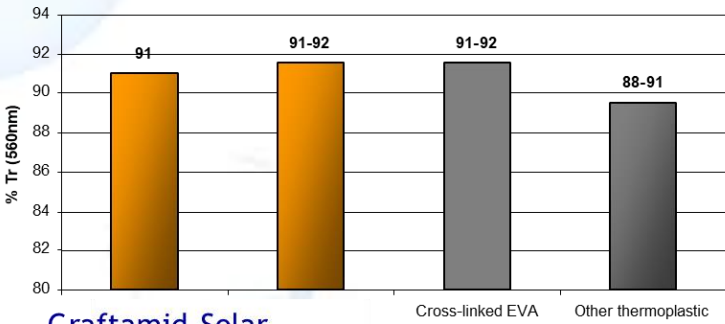
- Adhesive properties
- Protection
- Thermal ageing Electrical insulation, UV protection
- Provide thermal resistance to PE based film

Multilayers PE/Graftamid/PE, with improved creep resistance

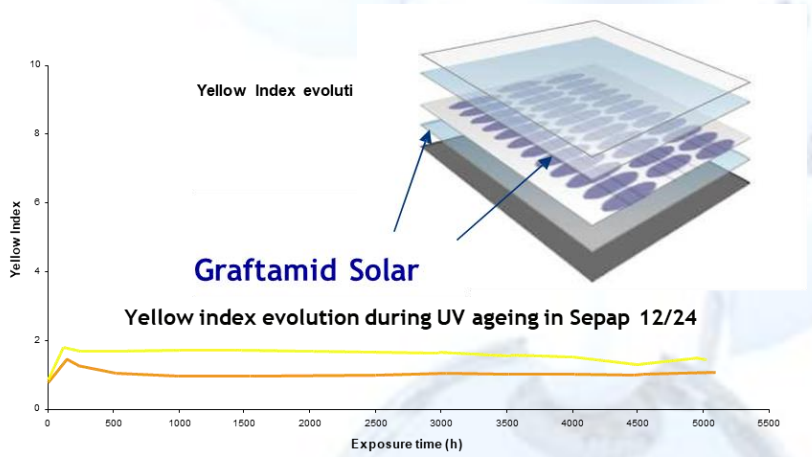
(+20/30° C) Multilayer Graftamid/PE/Graftamid, with improved adhesion performances

GRAFTAMID - for PV encapsulation

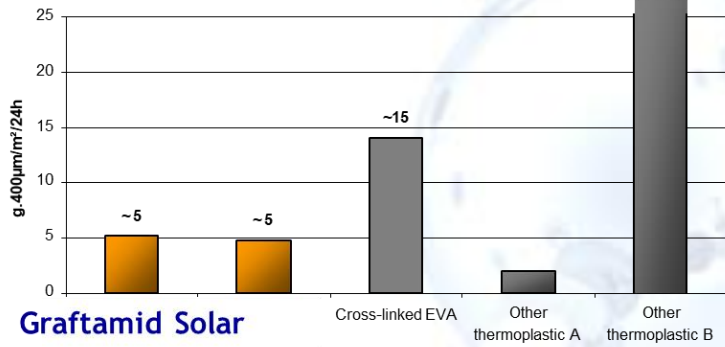
Transmittance at 560nm
Measurements on 400µm films



Graftamid Solar

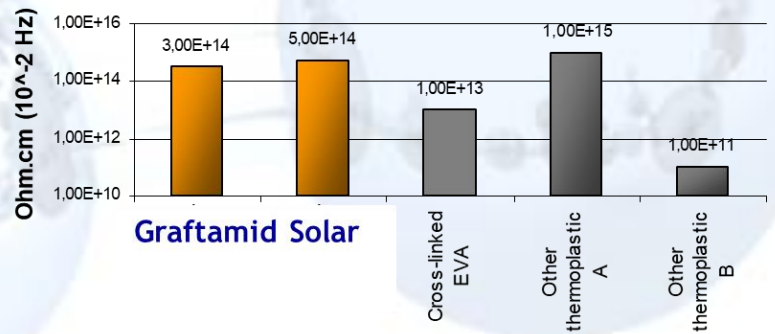


{23°C; 85%HR} Moisture Vapor Transmission Rate



Graftamid Solar

Resistivity
dry



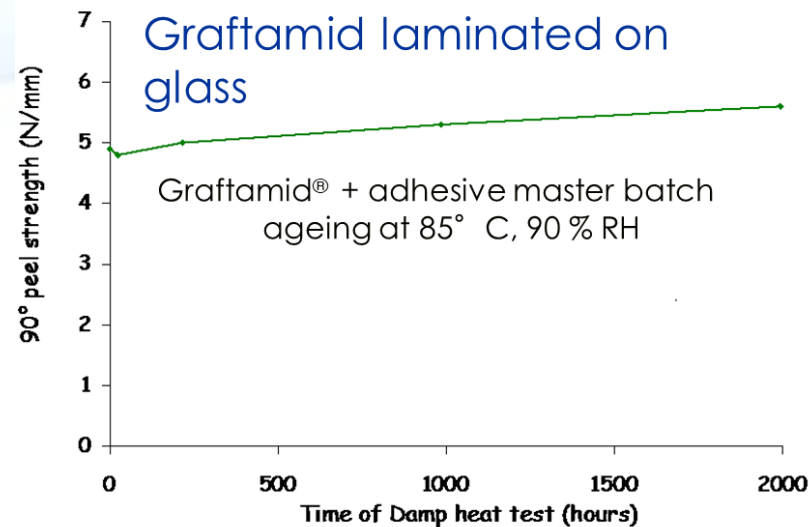
Graftamid Solar



GRAFTAMID adhesive properties

initial and during damp heat ageing

Graftamid laminated on glass



bi-injected, without surface treatment
Graftamid adhesion on polymers

Peel strength (N/cm)		
HDPE	51	10
PA12	66	8
PA6	36	6
TPU 59 Shore D	+++	23
PP homo	5	1
POM	< 1	ND
PET	9	4

- Good intrinsic adhesion properties **of many Graftamid grades**
- Graftamid can be used as a material or as an additive to improve other materials like polyolefins



GRAFTAMID - HFFR / FR applications

Development Graftamid HFFR and FR grades :

- Graftamid HFFR standard grades : cable, automotive
Cable sheathing, thermal protection, corrugated tubes
 - No halogen, UL94-V0, LOI up to 41 %
 - Low fume toxicity (F1/I2 NF F 16101)
 - Glow wire test : GWFI up to 920°C
- Graftamid LC HFFR transparent grades :
 - Technical films
 - No halogen, UL94-V2
- Graftamid FR (brominated) grades :
 - Automotive applications
 - Can be selected for superior mechanical & thermal resistance
 - Possible UL94-V2 grades without antimony trioxide (no labelling)



GRAFTAMID - as an additive

In Polyolefins or in TPV

- Possible dilution in HDPE, LDPE, ethylene copolymers and even in PP based formulations
- Twin screw extruders / single screw dilution possible
- **Adhesion** enhancement on nylon, glass, metal...
- **Thermal** properties enhancement (higher dosage) :
 - Possible > 10 / 20 °C increased thermal creep resistance
- **Example : over-moulding of modified TPV on PA + GF**

In Polyamids

- **Impact modifier**
- Low viscosity increase compared to conventional MAH modified additives
- Can also act as a co-additive, for instance compatilbizer for metallocene low density copolyolefins

In Hot Melt Adhesives - HMA (FPO or PA based)

- **Adhesion** enhancement
- **Thermal** properties enhancement (soft, ring & ball temperatures)

Note that HFFR are “ready-to-use” materials

Formulation of HMA with GRAFTAMID

Graftamid + EVA/EMA/EBA/EEA base resin

Example :

40 % of { Graftamid + EBA28BA175 (high flow) } mixtures

15 % Novares TN150

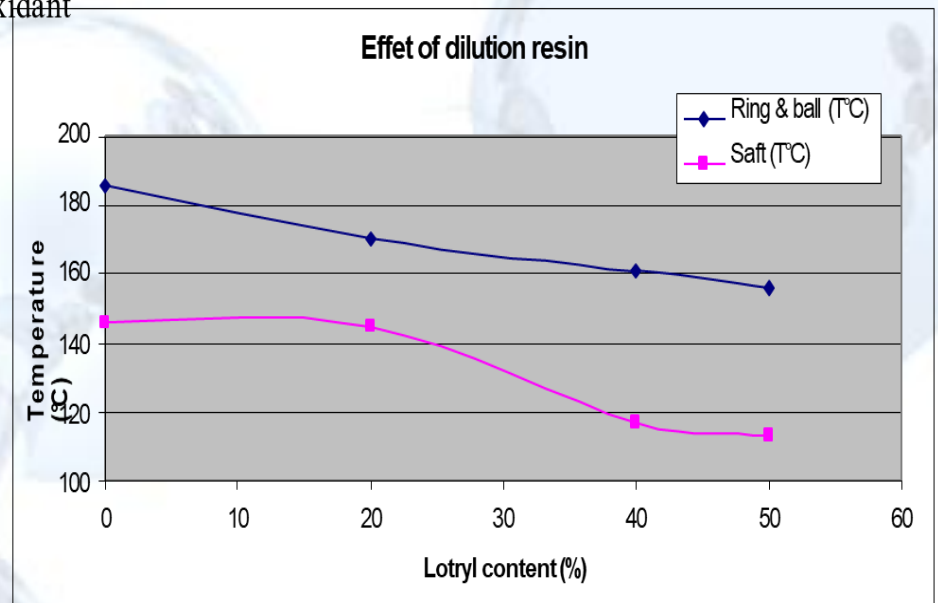
15 % Dertopoline P125

30 % fillers (calcium carbonate)

0.5 % anti-oxidant

① **Soft : 145–115**

① **Ring & ball : 190–160**



Graftamid for high performance HMA

GRAFTAMID Summarize

- A new class of nanostructured materials
- Co-continuous structure stable during processing

Graftamid shows synergistic performances :

- Flexibility and adhesion properties of Soft functional PolyOlefins
- Thermo-mechanical and chemical resistance of PolyAmids

Graftamid main performances

- Flexibility without plasticizer, modulus from 35 MPa to 1 GPa possible, Hardness 80 Shore A to 50 Shore D
- Good impact properties, ductile / brittle transition from - 60°C to -20°C
- Thermomechanical resistance, heat resistant up to 180°C under moderate loading
- Good chemical resistance (water, oil, salt, glycol...)
- Low density (< 1 except HFFR grades < 1.1)
- Adhesion on various substrates (polyolefin, polar polymers, metals, glass)
- Melting point adjustable up to 220°C
- Transparency (for natural grades)
- Electrical insulation
- FR or HFFR grades possible, UL94 V0, with high LOI and low fume tox
- Large ranges of viscosity: MFI (230°C, 2.16 Kg) = < 1 to 40 g/10 mn, possible extrusion (blow/cast/calendar), injection moulding, injection blow moulding...

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