CHEMISTRY THAT MATTERS™

NEW NANOTECHNOLOGY BASED SOLUTION FOR ENHANCED PET FOAMS

POLYMER FOAM VIRTUAL SUMMIT - AMI 2021

AGENDA

- SABIC Specialties introduction
- Foam core material for windmill blades – industry trends
- New nanostructured masterbatch for foams
- Conclusion -LNP™ COLORCOMP™ benefits

SABIC SPECIALTIES

SABIC: ONE OF THE WORLD'S MOST DIVERSIFIED CHEMICAL COMPANIES

BUSINESS PORTFOLIO

PETROCHEMICALS

- Polyolefins
- Polycarbonates and Blends
- PVC , Polyester and Polystyrene
- Functional Forms
- Synthetic Rubbers
- Specialty Polymers & Polymer Additives
- Fluids
- Glycols, Olefins, Oxygenates and Aromatics
- Chemical Intermediates & Industrial Gases

SPECIALTIES

- Specialty Engineered Thermoplastics
- Specialty Compounds
- Advanced Composites
- Additive Manufacturing
- Thermosets and Additives

AGRI-NUTRIENTS

Nitrogen
- Prilled Urea
- Granular Urea
- Ammonia

Phosphate
- DAP and Dark DAP
- MAP

Specialty
- NPK
- TGU

METALS*

Long Steel
- Rebar
- Wire Rod
- Rebar in Coil

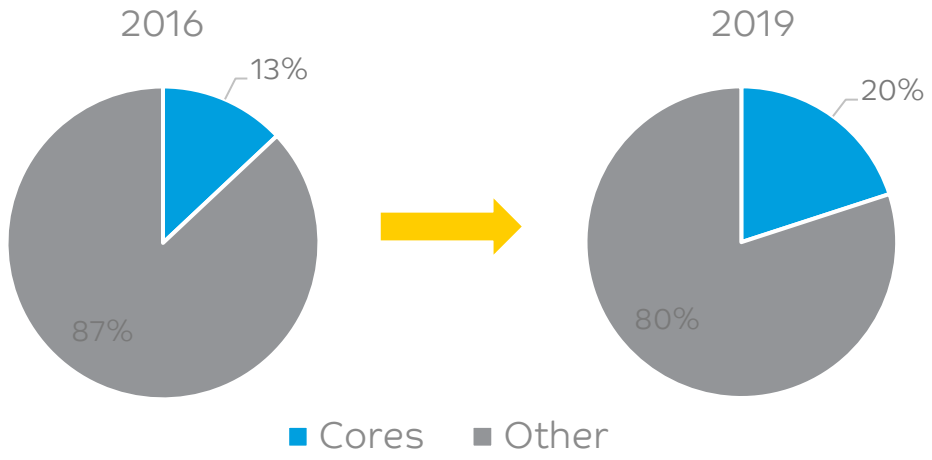
Flat Steel
- Hot Rolled Coils
- Cold Rolled Coils
- Galvanized Rolled Coils
- Pre-painted Rolled Coils

* Supplied under SABIC brand through Hadeed, a fully-owned SABIC Affiliate

MARKET TRENDS

FOAM CORE MATERIAL FOR WIND TURBINE BLADES – INDUSTRY TRENDS

APPROXIMATE GLOBAL MARKET SALES VALUE BY MATERIAL



MATERIAL TRENDS

- More differentiation in foam properties
- Sustainability – Recycled / Recyclable
- Balsa wood shortages (COVID19)
- Lower resin uptake for lightweight

PET is one of the fastest growing materials

MARKET GROWTH DRIVERS

Rising demand for Wind Energy
Europe: from current 12 GW to expected 300 GW in 2050 for offshore wind energy capacity

Repowering
Expected to increase blade demand in ~2GW in 2020 to ~5GW in 2025

Larger blades
Approaching 120m and requiring robust materials

Local supply chain
Leveraging local production to avoid potential disruption on global sourcing

Source: AMI consulting

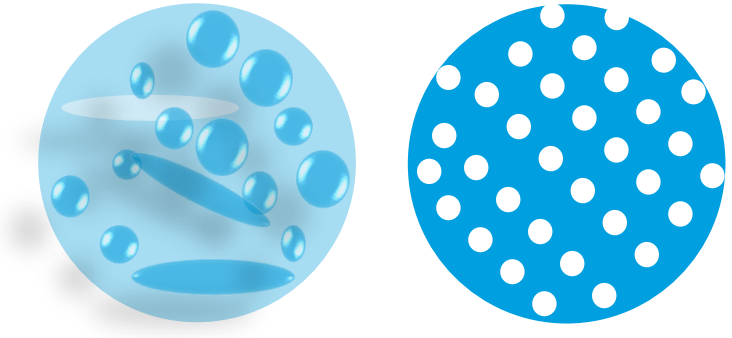
LNP™ COLORCOMP™ COMPOUND: NEW NANOSTRUCTURED MASTERBATCH FOR FOAMS

WHAT IS NEEDED TO MAKE A RESIN/COMPOUND FOAMABLE?

FOAM PROCESSES

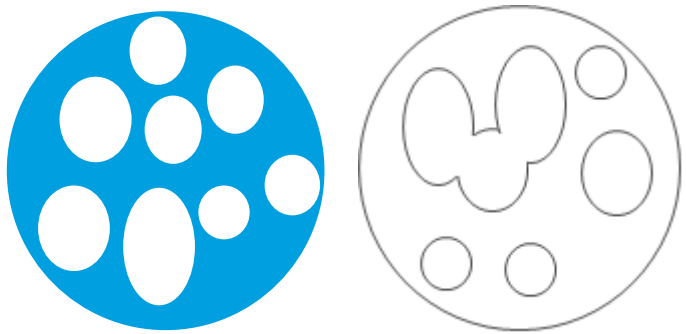
Extrusion
Injection Molding
Bead foaming

Gas diffusion and Nucleation



Dissolution and surface tension driven

Growth and Stabilization



Surface tension and viscoelasticity driven

CONTROL OVER NUCLEATION

RESIN	Chemistry, morphology
ADDITIVE	LNP™ COLORCOMP™ compound

CONTROL OVER CELL GROWTH

RESIN	Melt strength, glass formability crystallization
ADDITIVE	LNP™ COLORCOMP™ compound

The right balance and control of material properties controls foamability

LNP™ NANOSTRUCTURED MASTERBATCH FOR IMPROVED FOAMABILITY

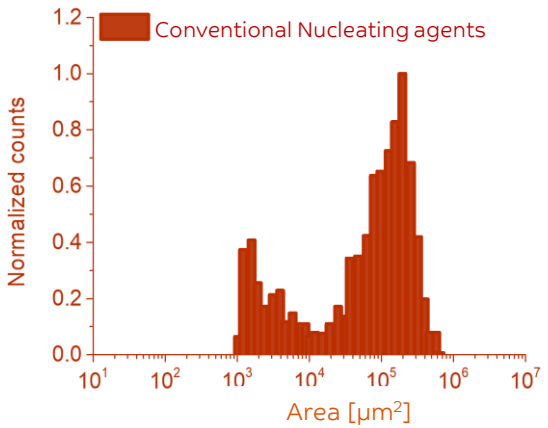
CUSTOMER CHALLENGE

Cost efficient production of foams with wide variety of densities on a flexible processing window with enhanced mechanical properties.

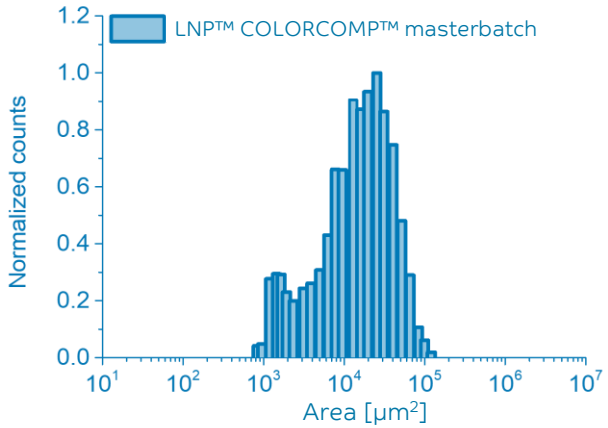
Better control over nucleation and cell growth while decreasing cell size and improving cell size distribution over the entire foam.

NANOSTRUCTURED MASTERBATCH

Special LNP™ nanostructured masterbatch can be used to achieve low-high density foams with potential for improved mechanical properties and extended foamability window by increase of melt strength and nucleation efficiency.



Average cell size 300 µm



Average cell size <130 µm

LNP COLORCOMP masterbatch for foams are a SABIC proprietary technology

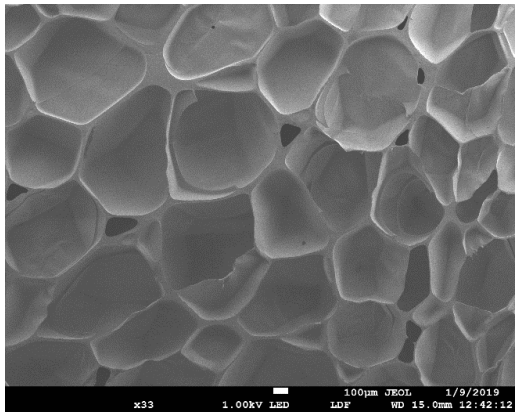
CELL MORPHOLOGY

At same foam density:

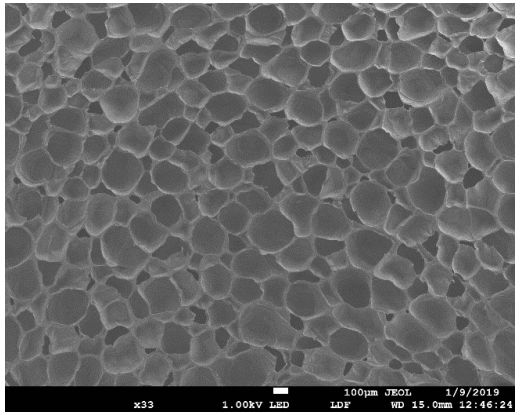
2-3x reduction on average cell size

Up to 5x reduction of cell size dispersity

Up to 40% reduction of resin uptake



Conventional nucleating agent

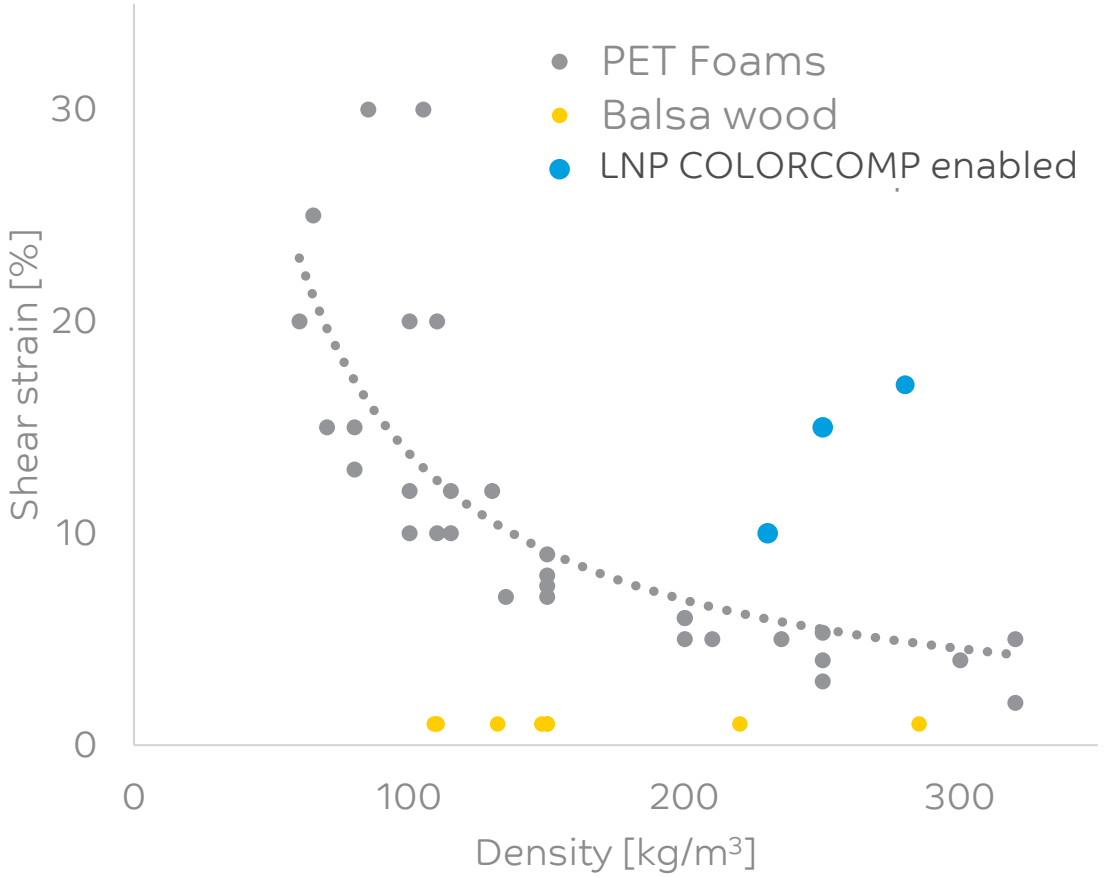


LNP™ COLORCOMP™ Masterbatch

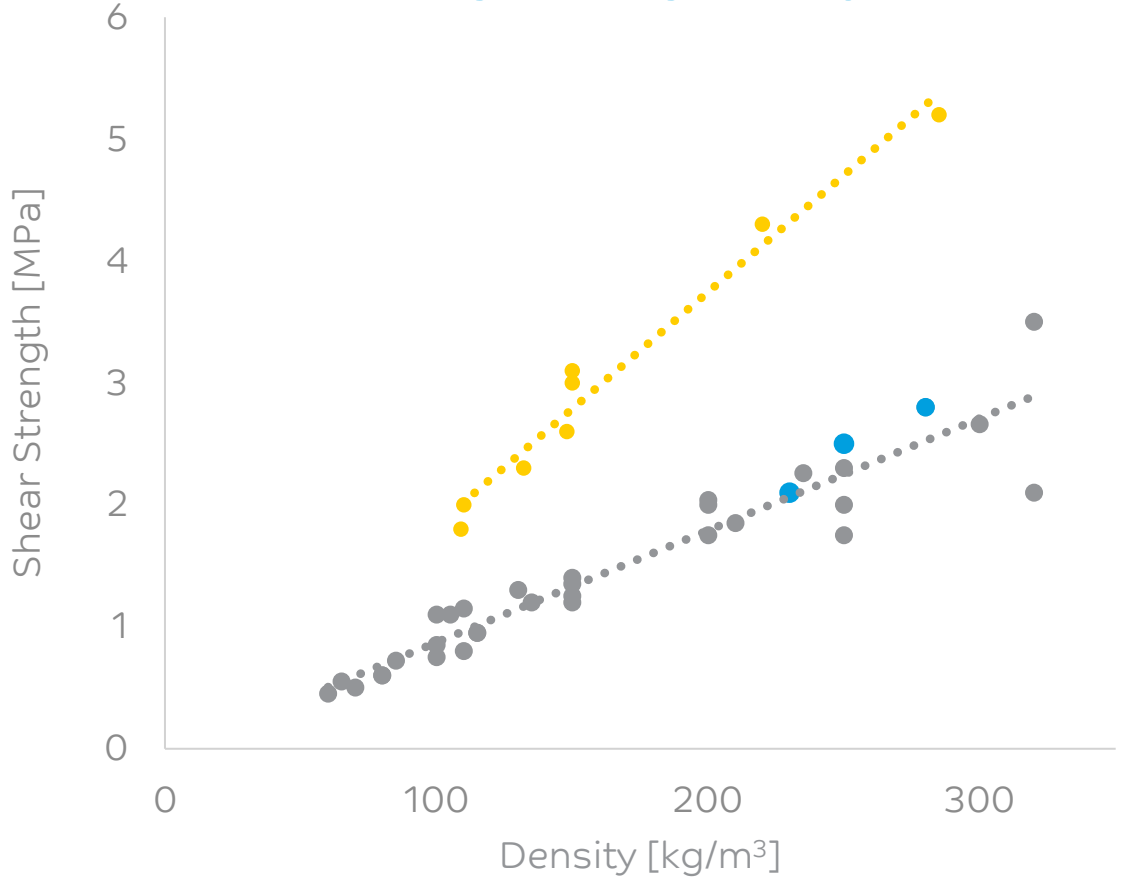
LNP™ nanostructured masterbatch based foams show smaller cell sizes

SHEAR PROPERTIES VS DENSITY

SHEAR STRAIN



SHEAR STRENGTH



LNP™ masterbatch based foams show higher shear properties over PET foams of the same density

SECONDARY POTENTIAL BENEFIT – RHEOLOGY MODIFIER

STANDARD CHEMICAL ROUTE FOR IMPROVED MELT STRENGTH

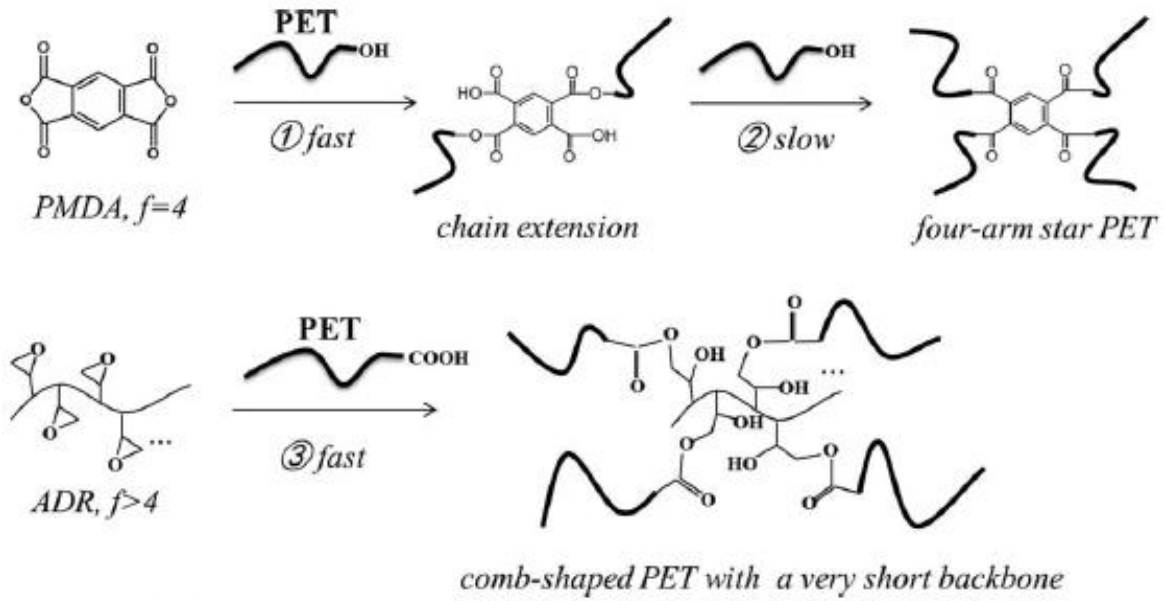
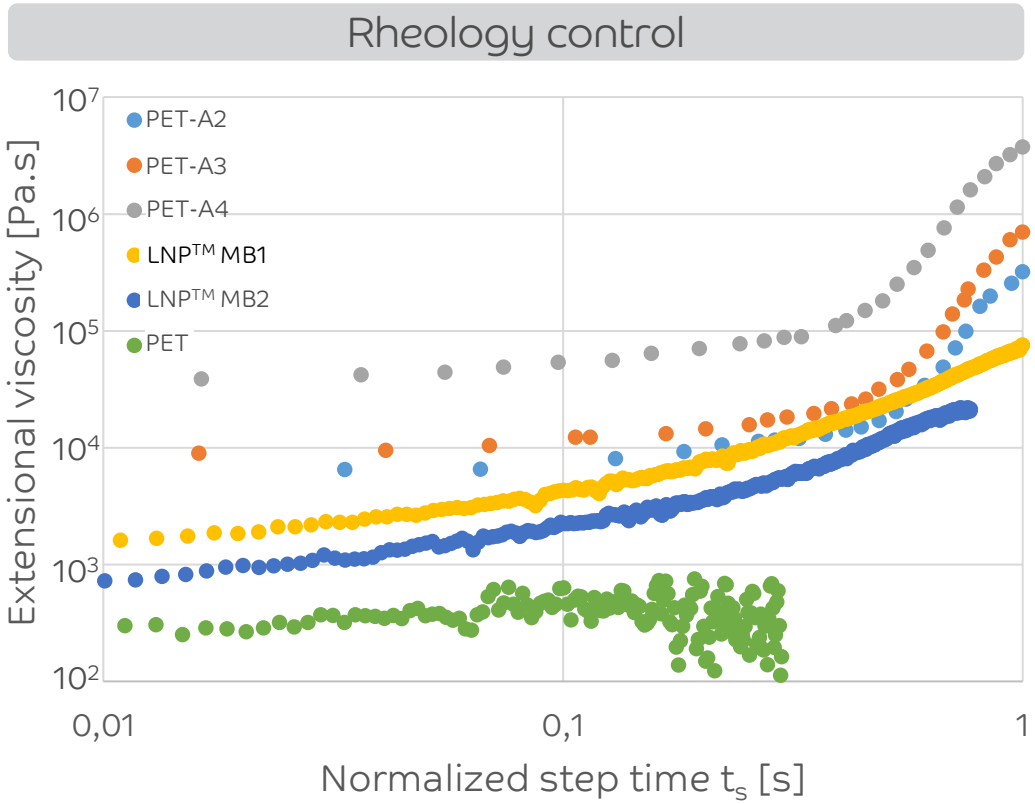


Figure 5. Possible topologies of PET after reacting with PMDA and ADR molecule.



Current solutions act by reacting with the PET base resin (branching or cross-linking) to give melt strength. Our solution gives also melt strength thermoformability to PET via a blending approach.

Yang, Z.; Xin, C.; Mughal, W.; Li, X.; He, Y., High-melt-elasticity poly(ethylene terephthalate) produced by reactive extrusion with a multi-functional epoxide for foaming. *Journal of Applied Polymer Science*, *135*, 45805, 2018.

CONCLUSION - LNP™ COLORCOMP™ BENEFITS

LNP™ COLORCOMP™ BENEFITS

VALUE FOR FOAM MANUFACTURERS

- 2-3x reduction on average cell size and reduce the cell size dispersity by a factor of up to 5 at same density
- Replacing nucleating agent & reducing chain extender
- Good shear strength, shear strain and resilience
- Potentially allows the use of rPET with less processing restrictions, improved foam recyclability for scrap material (no mineral filler present)
- Different densities are reachable broadening the scope for diverse range of CTQ's

VALUE FOR WIND ENERGY INDUSTRY

- Less epoxy resin uptake when making sandwich structures
  - Lower weight
  - Lower cost
- Potentially allowing the replacement of balsa wood and PVC
  - Thermoplastic solution: lower lead times vs balsa wood
  - Closed cell foam and potential benefit of less water uptake vs wood
  - Better environmental footprint vs PVC

OTHER BENEFITS

- Melt strength enhancer
- Thermoformability
- Propriety technology is resin independent, thus expanding the application space into insulation, building and construction, automotive, packaging and others

THANK YOU

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