NANO-COMPOSITES
&
CHALLENGING ISSUES
FOR THE USE OF NANO PARTICLES IN
POLYESTER FIBRE SPINNING

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INTRODUCTION OF KORTEKS YARN

• Korteks plant has one of the world’s largest capacity of single line continuous polycondensation and direct POY-FDY spinning
• Integrated filament yarn production plant with its daily production capacity of 580 tons polymer, 400 tons POY, 120 tons FDY, 350 tons textured yarn and 25 tons twisted, fancy and elastane covered yarn and 10 tons air jet textured yarn.
• Chemical and textile laboratories furnished with modern equipment aimed at research and development, process improvement and quality control operations.
• Korteks holds ISO 9001:2000 and ISO 14000 certificate from RWTÜV and TSE, as well as Oeko-Tex class 1 and class 4 certificate from Hohenstein.
Functional Polyester Products

- TAC ANTIMICROBIAL
- TAC FLAME RETARDANT
- TAC MICROMUSS
- TAC UV PROTECTION
- TAC DRY TOUCH
- TAC COTTONLIKE
- TAC ANTISTATIC
- TAC UV Resistant
- TAC COMFORT
- HEALTHGUARD
Nano Composites and Textile Applications

- Inclusion of nano particles into polymeric matrix yields new class of materials:
  - Nano-composites
- Applications exist in automotive, engineering, film sectors
- Nano-composites also offer opportunities for the textile industry
  - Nano-composite fibers provide permanent properties
  - Polymeric fiber matrix reinforced with nano-particles
Nano Particles for Fibres

• Organic and Inorganic spinnable fibres:
  – PET, PES, PA6, PA66, PP, PACN, PE, Viskon, PTFE, PVA, GF, CF, AR, etc

• Nano particles applicable in fibre spinning:
  – Nano sized metal oxides TiO$_2$, ZnO, SiO$_2$, CuO, Ag$^+$
  – Metal particles Ni, Cu, Au
  – Nano ceramics
  – Organically modified nano clays
  – Carbon nano tubes
Properties for Textiles

- Flame Retardency
- Antimicrobial
- Anti-static
- Self cleaning
- UV protection
- Thermo stability
- Abrasion Resistance
- Better mechanical Properties
- Faster dye uptake
- Deeper color intensitty
- Brighter colors
Expertise necessary for better interaction

- Establish a co-operation between:
  - Nano particle production
  - Masterbatch compounding
  - Polymer extrusion
  - Fibre spinning
  - Textile Downstream Processes

Raw Materials (PET)
- Nano additives
- Masterbatch
- Dispersion
- Viscosity
- Melt behavior

Processing
- Extrusion
- Spinning
- Texturization
- Finishing

Properties
- Physical
- Mechanica
- Structure
- Functional
Nano Particles

• Agglomeration
  – Difference of sub micron particle size
  – Higher disproportionality in nano particle converting
  – Higher interactions of particles lead to agglomeration
  – Due to increased specific surface area
  – Inversely proportional to particle diameters, range: ideally 20nm – 500nm
  
• Therefore it necessary;
  – Successful conversion of nano particles in real world product formulations
  – Conversion to make compatible with polyester matrix to bond nano particles chemically, surface modification is a key factor, chemically aided milling or grinding
  – nano particle size below 200nm
Dispersion and Distribution

- The agglomeration level and distribution of particles in a polymer thus on a chemical fiber has been analysed by using SEM combined with such elemental analysis methods of EDAX and FTIR.
Masterbatch Feeding

• **Side Extrusion**
  • A side extruder dose MB in melt phase into PET melt from main extruder
  • Large Scale and capacity

• **Gravimetric Feeding:**
  • Up to 3 feeder for solid state MB chips dosing into PET chips feeder before entering into main extruder altogether
  • So upto 3 kinds of MB can be fed
  • Computer controlled to vary dosing rate
Dispersion in Masterbatch

- There are two stages of dispersion involved in terms of fiber spinning; dispersion in the master batch and dispersion on the fiber itself. Dispersion of nano particles in a master batch polymer is shown where particle size distribution is in the range of 200-500nm.
POLYESTER SPINNING
Effecting parameters of spinning

- Density
- Viscosity
- Melt temperature
- Process temperature
- Filament diameter
- Spinning pump pressure
Crimp structure of microfilament yarn in comparison with standard yarns (dtex 100f 36)
• Viscosity affect pressure
• Spin pump – spin pack pressure
  – Adjustment necessary due viscosity effect of some additives
• Additives/reinforcement affect final physical properties:
  – tenacity rises → elongation drops
  – But this ratio changes due to difference in molecular chains
  – Tenacity and elongation drop
  – Along with chemical effect; particle size and dose rate have biggest effect
Winding issues

• Choose optimum winding speed depending on the effect of additive/reinforcement on yarn physical properties
• Friction properties
Textile Processes

• Texturizing
  – Draw, temperature 150-400°C, friction discs

• Twisting 5-1500tpm

• Weaving knitting
  – Friction, tenacity, elongation

• Dyeing & Finishing
  – 130°C, 200°C, shrinkage, chemicals
Dispersion on Fiber

- Dispersion of fibers after spinning the agglomeration has been reduced by more homogenous distribution of particles being of 200nm on average as shown
THANK YOU FOR ATTENTION!!!