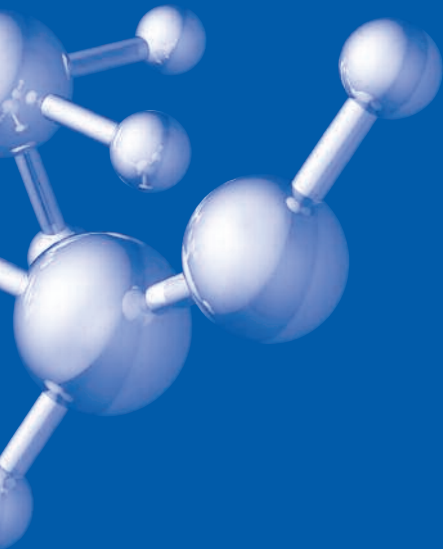




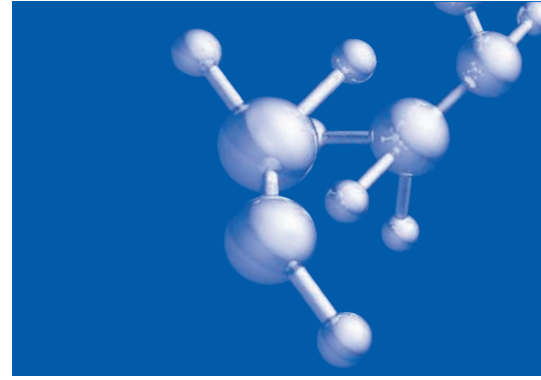
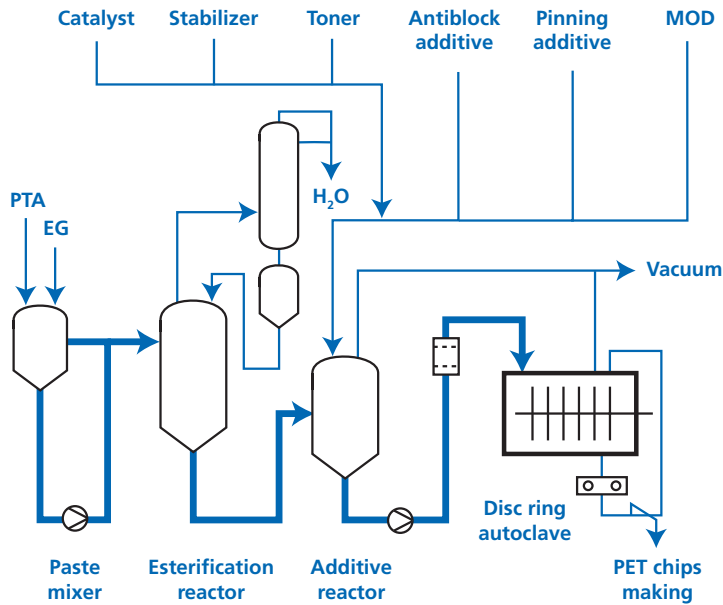
Zimmer® Polymer Technology  
**Film Grade Polyester**





## Introduction

Worldwide, polyester polymer for film is produced based on the Zimmer® process technology, in China, India, Indonesia and Spain. More than 30 years of development work, coupled with continued collaboration with our customers has resulted in the most advanced plant design and technology for PET film polymer. Polymer plants built with Zimmer® technology ranging from small multipurpose or pilot plants to high-capacity continuous production lines and batch plants.



Batch process – for capacities up to 120 t/day – special design Raw material: PTA/EG

## The polyester process

Polyethylene terephthalate is known as one of the most widely used polymers for the production of

- Packaging film (mono or multi layer)
- Stamping foil
- Electrical insulation
- Insulation film for capacitors
- Transparency slides (OHP film)
- Graphics
- Magnetic media

Most of these film types require the addition of special additives to achieve the desired properties such as:

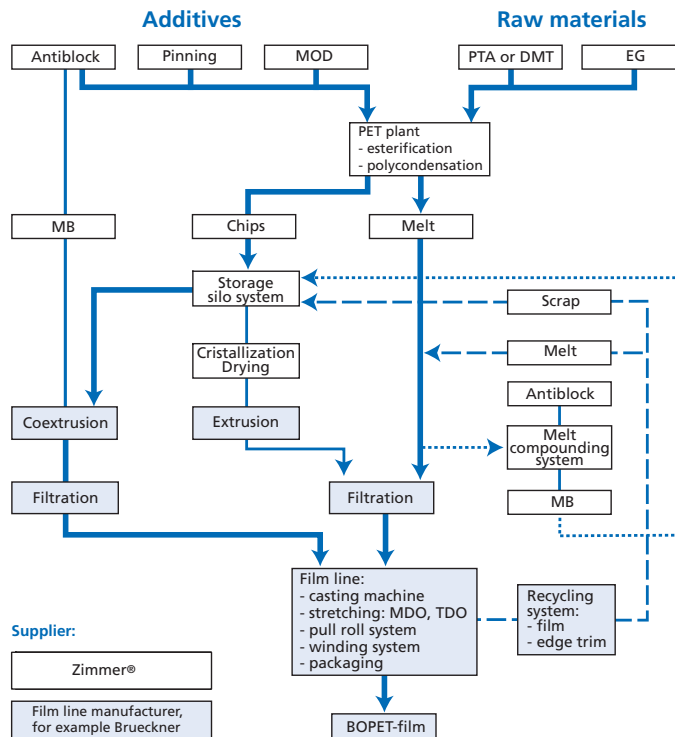
- Good pinnability
- Surface roughness of the base film – antiblocking
- Good windability
- Improved coating properties

The batch process is best suited for the production of different PET film types in small capacities (production in campaigns). Lurgi can offer batch plant capacities up to 120 t/day per line with unique design especially for the production of high quality film PET. For larger capacities (> 120 t/d)

the continuous process is selected. In the most economic plant concept the melt from continuous polycondensation is directly fed to the die units of several film lines. Thus, investment and utility cost can be saved. Chips for the conventional route and MB-chips (with pinning additives) can be produced in parallel with the direct process.

### The technology package for production of polyester film

Production of film grade polyester for BOPET	Zimmer®
Additive preparation and addition - Antiblock additives for adjusting surface roughness - Pinning additive to achieve highest film line speed - MOD additive to improve drawability of film and performance of film line	Zimmer®
Film production technology (including recycling)	Film line manufacturer (z. B. Brückner)
Special analysis	Zimmer® / film line manufacturer



Continuous Polycondensation Technology for BOPET-Film

### From polymer to film

A complex relationship exists between the necessary properties for the different film types and the respective polymers and film processing technologies (see table "Necessary properties"). The development of the different additive systems was carried out in close cooperation with Brückner Maschinenbau, a company which operates a semi-commercial film processing line.

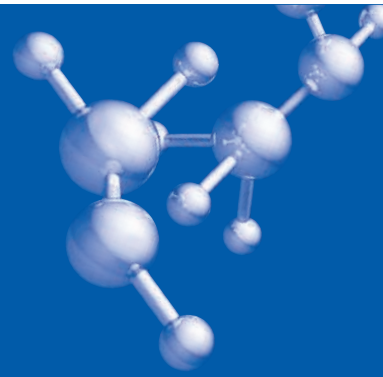
### Selection of the film additives for adjusting surface roughness

For the film producer, the correct selection of additives is decisive, because the production and processing of the polyester film as well as the quality of the end product are influenced to a great extent, by the right additive. Each film type requires a special additive concept, taking into account the concentration, type of additive and particle size distribution. It may also be necessary to mix additives of different particle size so as to achieve the required surface characteristics. The surfaces of typical film samples produced using

Zimmer® additive technology are shown under 250 x magnification by interference contrast microscopy, together with their surface roughness RA results and some application examples.

The additives have to meet the following important requirements:

- Stringent particle size distribution
- Chemically inert in the polyester process
- Easy dispersion in ethylene glycol
- No tendency to re-agglomerate during processing
- Suitable for film use e. g. transparency, colour, electrical
- Properties, abrasion properties



Additive Type	Interference contrast picture (magnification 250 times)	Surface roughness RA [ $\mu\text{m}$ ]	Application
ZFA 14		0,010	Magnetic: - Video
ZFA 11		0,018	Magnetic: - Video, computer, floppy disc  Electrical insulation: - Capacitors
ZFA 12		0,025	Magnetic: - Audio, computer, floppy disc  Electrical insulation: - Motors, cables, transformers, graphic art
ZFA 21		0,030	Packaging and industrial: - Food packaging, incl. metallized film, lids, labels, laminates, adhesive tape, stamping foil  Electrical insulation: - Motors, cables, transformers, graphic art
–	No special surface requirement	–	Graphics: - Y-ray film, phototechnical film, transparency slides (OHP film), displays, graphic art

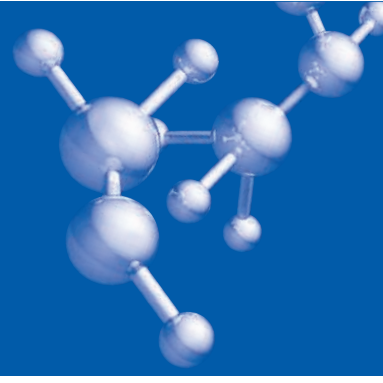
Film additives and examples for applications

Film types and application		Packaging and industrial	Graphic	Electrical	Magnetic
<b>Polymer properties</b>					
High purity of base polymer	▲	++	+++	+	+++
Homogeneous polymer extremely low deviations in quality parameters	▲	+++	+++	+++	+++
Improvement of electrical conductivity for highest film line speed	▲ ■	+++	+	-	+
<b>Film properties</b>					
Film thickness [microns]	●	6-250	100-200	1-350	6-75
Thickness tolerance	●	+	++	++	+++
Tensile strength	●	+	+	+	++
Elongation at break	●	+	+	+	++
F 5 value	●	+	+	+	++
Modules of elasticity	●	+	+	+	++
Thermal shrinkage	▲ ●	++	+++	++	++
Friction coefficient	■	+	-	++	++
Surface roughness	■	+	-	+	++
Dielectrical strength	■	-	-	+	-
Electrical defects	▲	-	-	++	-
Dielectric constant	■	-	-	+	-
Dissipation factor tan delta	■	-	-	+	-
Surface resistance	■	-	-	+	-
Volume resistance	■	-	-	+	-
Gloss	■ ●	++	-	-	-
Haze	▲ ■	++	+	-	-
Transparency	▲ ■	+	++	-	-
UV-Absorption	▲	+	++	-	-
Surface tension	▲ ■	+	-	-	-
Drop-out level	▲ ■	-	-	-	+++
Colour tone	▲ ■	+	-	-	-
Windability	■	+	-	++	++
<b>Main advantages</b>		Good barrier properties	High dimensional stability	High volume resistance	High tensile strength
		High dimensional stability	Long lasting transparency	Good dielectrical strength	Good dimensional stability
		Excellent resistance to chemicals, moisture and water vapour	High purity	Good chemical, thermal and physical properties	Excellent flatness, thickness
<b>Legend</b>	▲ Influenced by polycondensation ■ Influenced by additives	● Influenced by film line +++ decisive	++ very important + important	- not important	

Necessary properties for polymer and films



Process control system



Lurgi is a leading technology company operating worldwide in the fields of process engineering and plant contracting. The strength of Lurgi lies in innovative technologies of the future focusing on customized solutions for growth markets. The technological leadership is based on proprietary technologies and exclusively licenced technologies in the areas gas-to-petrochemical products via synthesis gas or methanol and synthetic fuels, petrochemical, refinery technology and polymer industry as well as renewable resources/food.

Lurgi is a member of the Air Liquide Group



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