

Enhanced Properties of Oriented Films by Simultaneously Stretching

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Introduction

Changing requirements from the markets for biaxially stretched films for packaging purposes in the recent years have urged plastic film producers to react on this trend with an adapted product spectrum and the machinery industry with appropriate production lines. An economical production of standard film types can be made on production lines with high output rate, whereby a trend to larger width (up to 10 m) and higher production speeds (up to 450 m/min) can be observed. Dependent on ecological and economical fundamentals, a continuous trend for downgaging becomes apparent. A further tendency toward an increasing quantity in special films with modest market share but higher added value can be ascertained. In some extent, new products are generated from substitution attempts, for example for polyvinyl chloride (PVC) and paper, by modified polyethylene (PE) or polypropylene (PP) films. These developments emerging in the packaging markets require production lines with high output rate on the one hand and great flexibility, short product change-over times and the possibility of integrating conversion processes.

Aside the continuous development of sequential stretching lines (longitudinal and transversal orientation of the film is performed successively), Brückner Maschinenbau GmbH also advances new developments of simultaneous stretching machines (longitudinal and transversal orientation is done simultaneously). In addition to the mechanical equipment (spindles, pantograph) the LISIM[®] technology (simultaneous stretching line with linear motors) (Fig. 1) represents a key tool to meet these changing requirements on the films and the opportunity of film production with new property profiles is made available (Fig. 2). This can be outlined here on the basis of simultaneously biaxially stretched polypropylene films (S-BOPP).

Downgaging

The trend to downgaging, in particular with BOPP films, is intensified by the ecological legislation. Thereby, in the production process a major criterion is stable runnability, i. e. production with a minimum of film breaks at maximum speed, whereas for the converting and packaging industry machinability and the optical properties of the films are relevant. The LISIM[®] technology has proven that an improvement of the mechanical characteristics by up to 70 % in combination with outstanding optical properties at good runnability can be attained. This is realised by the principle of contact-free stretching at low strain rates in the course of simultaneous stretching. While in the sequential stretching process stretching ratios of 5.5 (in machine direction (MD)) x 9 (in transverse direction (TD)) a Young's modulus of 1400 to 2600 N/mm² in longitudinal direction is achieved, the LISIM[®] process enables stretching ratios of 9.5 (MD) x 5.5 (TD) and a Young's modulus of up to 4000 N/mm² in longitudinal direction. These improvements in film properties are advantageous for cigarette packaging films, lamination films, labels, adhesive tape films and others whereby downgaging of 20 to 30 % is achieved.

Improvement of Optical Properties

This contact-free stretching process, where neither at preheating nor during stretching contact of the rolls occurs, enables the production of films with excellent optical properties showing high gloss values and surfaces clear of scratches. These properties result in particularly high-grade metallisation and lamination films.

Enhancement of Sealing Characteristics

A further advantage of the contact-free stretching process is the possibility of producing coextruded film types with low sealing temperatures or with particularly thick sealing layers in order to increase the sealing strength. At present, sealing temperatures of < 75 °C and sealing strengths of > 7 N/15 mm have been achieved.

Low Shrinkage Values

The LISIM[®] process not only allows the various stretching profiles for optimized orientation but also the specific relaxation in MD and TD during or after annealing. This is used in order to balance and minimize

shrinkage values. In particular for lamination and lidding films, improved application purposes are revealed.

Isotropic and anisotropic Shrink Films

Instead of relaxing during annealing, the stretching process can be continued, in this case, resulting in shrink films with high shrinkage values, thereby achieving either balanced, high shrinkage values or adjusting high shrinkage values in machine direction and at the same time low shrinkage values in TD. Dependent on the raw material used (PP homopolymer, PP random copolymer and blends PP with LLDPE) and the stretching parameters, shrinkage values between 0 and 70 % (measured at 130 °C, 5 min in air) can be adjusted. Such shrink films stretched in both directions are applied for packaging purposes as substitute for PVC shrink films. Shrink films stretched only in MD are mainly used for the label market. Typical of all shrink films is the specific adjustment of the shrink characteristics in MD and TD for any application purpose which is perfectly performed with the LISIM® process.

Foamed Films

As a further example for films which can only be produced with the simultaneous stretching process, biaxially stretched foamed films can be mentioned. These new film types are still in the stage of development but have successfully been produced on the Brückner Pilot Line. In this process chemical foam additives are used which form the necessary foam structure in the cast film. The following simultaneous stretching process leads to the desired optical properties and the low density of less than to 0.21 g/cm³. Such film types reveal application potentials for packaging films, thermal insulation films and synthetic paper.

Inline – Coating

Inline-coated films, also in experimental stage, are to be mentioned as a further film development. Here, aqueous solutions are applied by the use of an inline-coater before the simultaneous stretching process, afterwards and after predrying uniformly stretched with the cast film. Successful tests with primer, PVDC and acrylic coatings have so far been carried out. This process enables the cost-reasonably integration of the desired conversion measures for increasing the sealing and barrier properties into the production process.

Other Film Types

Aside from the examples of property improvements for BOPP films outlined above, the advantages of the LISIM® process are also valid for other materials. So far, positive test runs on the Brückner Pilot Line have been performed with BOPET, BOPE, BOPA, BOPLA and other film types. The results have partly been published in former documentations.

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