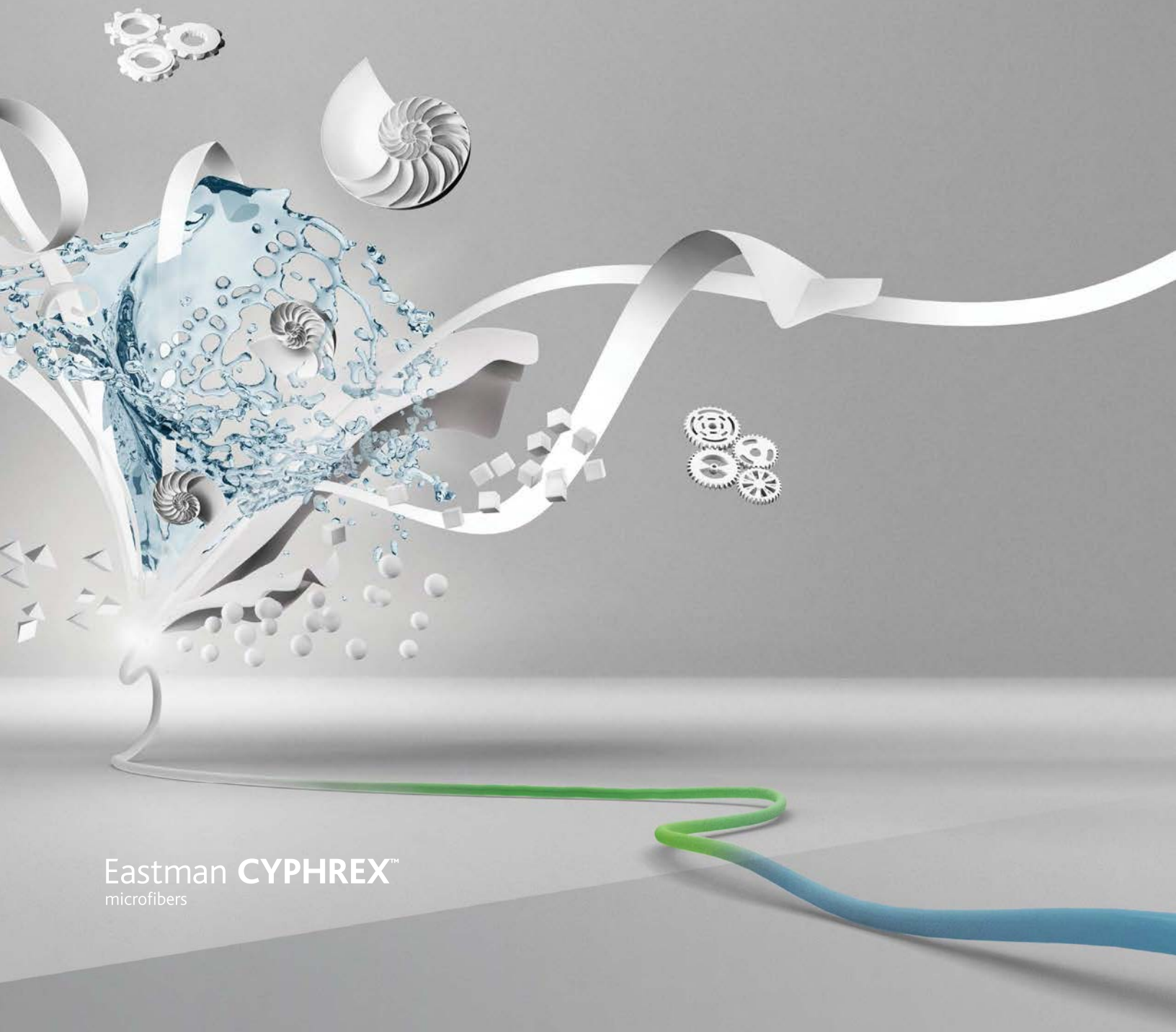
Eastman Cyphrex™ PET Microfibers for

WET-LAID NONWOVENS AND PAPER

Synthetic fibers are often used in commercial wet-laid nonwoven and paper applications to impart improved performance for properties such as tear resistance, tensile strength, dimensional stability, pore size control, and permeability. However, it is well understood that processing of synthetic fibers in wet-formed systems can often present challenges due to relatively poor inherent fiber dispersibility. This can, in turn, lead to both poor substrate uniformity and poor substrate processibility, specifically in transferring from the forming wire to the reel as a result of weak interfiber bonding.

A new class of synthetic materials, Eastman Cyphrex™ microfibers, were developed specifically to be well-suited for processing in existing wet-laid nonwoven and paper equipment in order to allow for unprecedented sheet uniformity and significant interfiber bonding and, consequently, strong, uniform, and potentially very lightweight synthetic substrates.



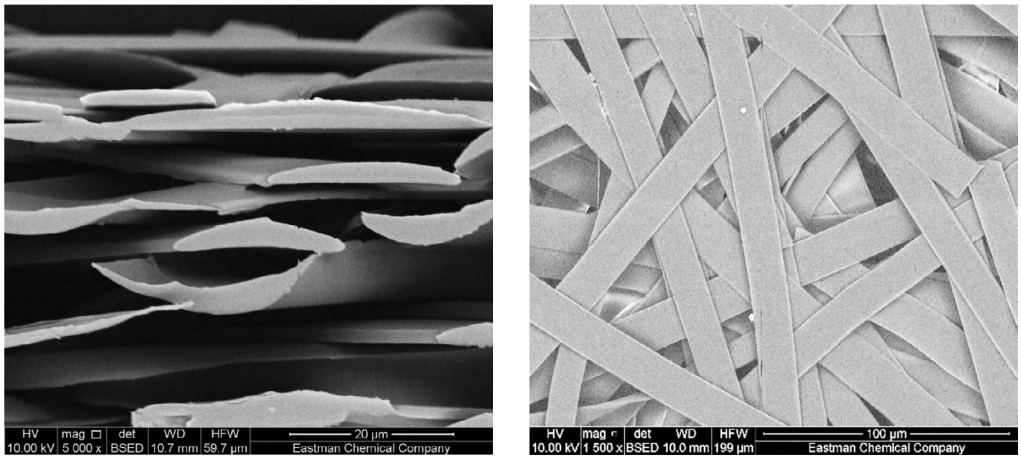
Eastman **CYPHREX**™
microfibers

UNIQUE WET-LAID SYNTHETIC FIBER

Eastman Cyphrex™ 10101 is a novel polyethylene terephthalate (PET) microfiber with a nominally flat cross section having average dimensions of 2.5 microns thick and 18 microns wide and a precision-cut length of 1.5 mm (Figure 1). This unique combination of geometry and physical dimensions contributes significantly to the exceptional dispersibility of these fibers (more akin to cellulose in that regard than to "typical" synthetic fibers). In addition, these attributes result in nonwoven/specialty paper materials with levels of strength, uniformity, and durability that are unexpected with a synthetic fiber. While they can be blended effectively with cellulosic materials (refined and unrefined), it is atypical that the inherent internal bond strength of Cyphrex microfibers is such that binder-free 100% polyester papers can be easily prepared from these materials. This functionality can provide potential design flexibility for the nonwoven/paper product development specialist that is well beyond the reach of typical wet-laid PET fibers due to the constraints imposed by their aforementioned inherent lack of wet and dry interfiber bond strength.

FIGURE 1

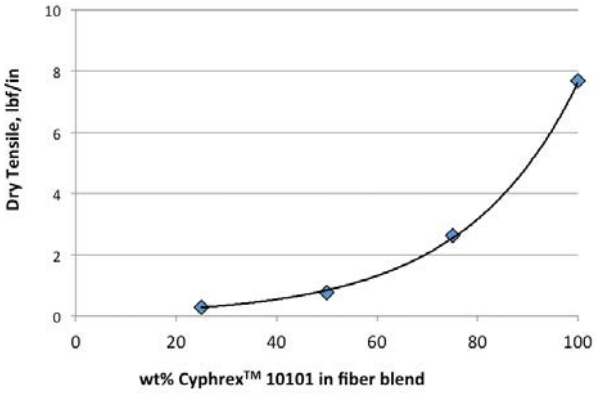
Cross-section and surface micrographs of 100% Eastman Cyphrex™ 10101 handsheet



As a demonstration of these seemingly unique strength characteristics, laboratory handsheets were prepared from blends of Eastman Cyphrex™ 10101 and a commercially available 6 mm long, 6 micron diameter PET fiber and evaluated for tensile strength (Figure 2). It is important to note that not only does the inclusion of Cyphrex 10101 in the media provide meaningful improvements in dry tensile strength, but also there is sufficient wet strength in the 100% Cyphrex microfiber sheet to allow for easy removal from the forming wire and subsequent placement onto a drier can. In contrast to this, numerous attempts to make handsheets for testing from 100% of the commercially available PET microfiber (i.e., the "missing" 0% Cyphrex 10101 data point in Figure 2) were completely unsuccessful as the formed sheets quickly disintegrated during any attempt to remove them from the handsheet mold and dry them due to the lack of interfiber bonding. This wet-strength benefit has also been demonstrated to translate quite effectively to commercial-scale equipment to provide for more robust processibility.

FIGURE 2

Eastman Cyphrex™ 10101 microfibers in 80 gsm handsheet blends with a typical PET microfiber for wet-laid nonwovens (6 mm length and 6 micron diameter)

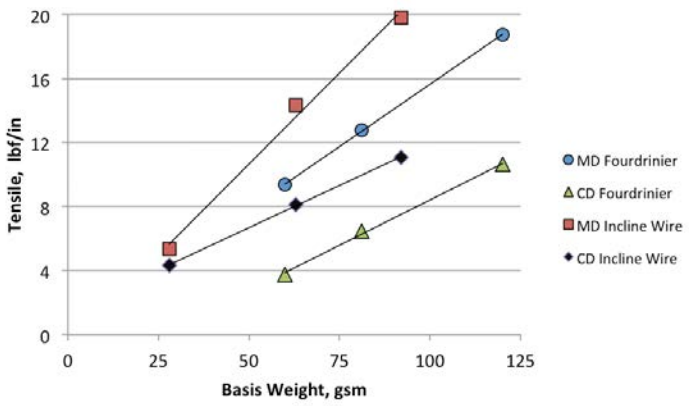


PROCESSING ON WET-LAID MACHINES

In addition to this unique potential benefit of enabling easy access to 100% synthetic fiber media in standard wet-forming processes, the design of Eastman Cyphrex™ 10101 microfibers allows for them to be processed at significantly higher furnish consistencies than is possible with other synthetic fibers. Figure 3 provides a comparison of dry tensile strengths (machine-direction and cross-direction, or MD and CD, respectively) as a function of basis weight for compositionally identical sheets prepared on a high dilution incline wire machine and a high consistency flat wire Fourdrinier machine. In the case of the Fourdrinier process, the flat PET microfibers were initially dispersed in a pulper at 3.2%, which is significantly higher than the dispersion consistency required for use of most synthetic fibers (typically 1% or less). This high consistency microfiber dispersion can then be readily diluted to 0.4% to 0.7% for processing at the headbox of the flat wire machine. It should be noted that the tensile strengths demonstrated by the 100% Cyphrex 10101 sheets in Figure 3 are quite significant when one recalls the previous discussion that sheets that solely comprise previously available PET fibers cannot be easily prepared, if at all, using typical web processing/conveying techniques.

FIGURE 3

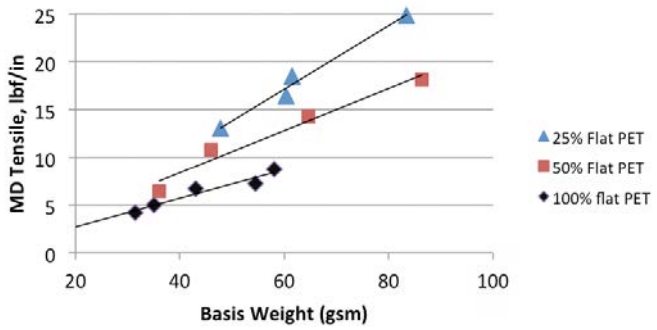
Tensile strength as a function of basis weight of 100% Eastman Cyphrex™ 10101 PET microfiber media produced on different types of wet laid nonwoven machines



It is this unprecedented ability of a synthetic fiber to be dispersed at high consistencies that also enables the processing of Eastman Cyphrex™ 10101 PET microfiber on flat wire equipment in a manner similar to cellulose. With accessible dispersion and headbox consistencies that are very similar to those used for processing of cellulosic materials on flat wire equipment, these new microfibers can be readily interdispersed and blended with cellulose fibers at essentially any desired ratio. While a number of methods can be used for combining fibers, the preferred method is to mix a cellulose fiber dispersion with a flat PET microfiber dispersion in the drop chest or machine chest. Figure 4 depicts the relationship between dry tensile strength, basis weight, and fiber makeup for substrates comprising blends of Cyphrex 10101 and refined cellulose as prepared on a Fourdrinier. Not surprisingly, cellulose fibers offer significant bond strength in a dry sheet. It is again worth stating, however, that the bond strengths of the 100% Cyphrex microfiber sheets are significant when one considers that these sheets could not be prepared in a wet-forming process from other synthetic fibers. Further, none of the materials described in Figure 4, even the 100% flat PET microfiber sheets, contain any type of binder (liquid or fiber) for strength. This can potentially reduce or, in some cases, even eliminate the need for a material or process step that would generally be a requirement for substrates in which the majority component is a more typical PET fiber.

FIGURE 4

Tensile strength as a function of basis weight of 100% Eastman Cyphrex™ 10101 PET microfiber media and blends with 200 CSF cellulose produced on a flat wire Fourdrinier machine

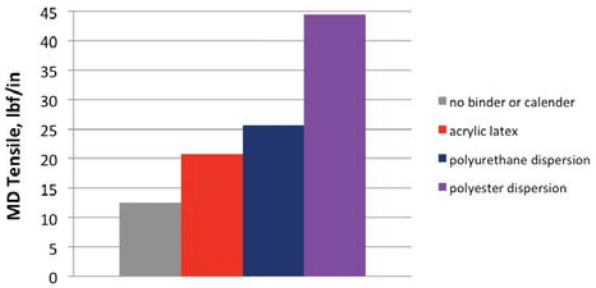


ADDITIONAL STRENGTH WITH BINDERS

With earlier comments as to the strength of binder-free substrates comprising Eastman Cyphrex™ 10101 microfibers notwithstanding, it is quite common when adding PET fibers to paper substrates, to apply a latex binder to provide adequate bonding with the synthetic fibers to achieve the desired properties of strength and dimensional stability that are required by the final end use. Similarly, such binders can be used to further enhance the strength already inherent in sheets comprising the Cyphrex 10101 microfibers. As an indication of the strength Cyphrex 10101 microfibers can contribute to nonwoven and specialty paper applications, 100% microfiber sheets, which as previously stated have outstanding strength properties in their own right, were treated with a number of waterborne binders at approximately 10% add-on weight. As can be clearly seen in Figure 5, the strength of a 100% synthetic sheet enabled with Cyphrex 10101 can be enhanced significantly by the application of the appropriate binder. The level of strength achieved in Figure 5, in fact, compares quite favorably with a number of high-strength synthetic roll goods in the marketplace.

FIGURE 5

Strength development of 80 gsm sheets of Cyphrex™ 10101 upon addition of a waterborne binder dispersion (approximately 10% binder add-on)



CONCLUSION

Due to their unique geometry and composition, Eastman Cyphrex™ 10101 microfibers behave much differently than existing synthetic fibers for wet-laid nonwoven and specialty paper applications. Unlike synthetic fibers typically used in developing these types of products, these novel flat PET microfibers were specifically designed for dispersibility and bonding in both the wet state and the dry state, which allows them to exhibit wet-laid processing characteristics that are very similar to cellulose fibers. These fibers can also be easily blended with cellulosic fibers to improve uniformity of the substrate while maintaining strength in these nonwoven and paper products. With Cyphrex 10101, wet-formed substrate producers have been enabled to create high-performing, high-strength synthetic materials on standard processing equipment. This allows them to ultimately deliver desired product performance attributes to their customers without any of the final trade-offs that typically come when adding synthetic fibers to cellulose fiber furnishes.

Eastman Cyphrex™ microfibers bring together world-class technology and a proprietary microfiber process that lets Eastman produce synthetic microfibers in unique combinations of sizes, shapes and materials. The technology behind Cyphrex is unlike anything else on the market.

ABOUT EASTMAN

Eastman is a global specialty chemical company that produces a broad range of products found in items people use every day. With a portfolio of specialty businesses, Eastman works with customers to deliver innovative products and solutions while maintaining a commitment to safety and sustainability. Its market-driven approaches take advantage of world-class technology platforms and leading positions in attractive end-markets such as transportation, building and construction, and consumables. Eastman focuses on creating consistent, superior value for all stakeholders. As a globally diverse company, Eastman serves customers in approximately 100 countries and had 2014 revenues of approximately $9.5 billion. The company is headquartered in Kingsport, Tennessee, USA, and employs approximately 15,000 people around the world. For more information, visit www.Eastman.com.

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MF-NW-015 05/15