

Microdenier Wipers in Critical Cleaning Applications

Our thanks to Texwipe for allowing us to reprint the following article.

Products used in cleanroom environments often have their origins in the consumer market. Microdenier (or microfiber, the terms are used interchangeably) wipers are no different. These products were introduced in the early 1970s as artificial leather.¹

Microfiber material is currently used in a broad range of consumer applications including apparel, eye glass cleaning, furniture covering, and car detailing. Microdenier fabrics feel soft, are durable, and have the ability to wipe surfaces clean even without using a wetting agent.

Microdenier wipers are increasingly gaining acceptance for use in cleanroom environments because of their ability to perform well in critical cleaning applications.

What is Microdenier?

Microdenier fabrics are constructed differently compared to traditional fabrics. Microdenier fabrics are made from synthetic yarns, generally bi-component polyester-nylon polymers, or 100% polyester polymers. Many filaments are processed together to form a yarn that will eventually be formed into a fabric. The size of the yarn is defined as the denier. A denier is equal to the weight in grams of 9,000 meters of yarn.



Figure 1a. The photograph shows a high resolution optical image cross-section of a bi-component 70% polyester, 30% nylon microdenier yarn. A whole filament is the round filament on the center left of the photograph. The small triangles scattered throughout the photograph are the nylon portion of the filaments that has broken free from the polyester backbone. These smaller filaments can break to form free contaminating particles or fibers.

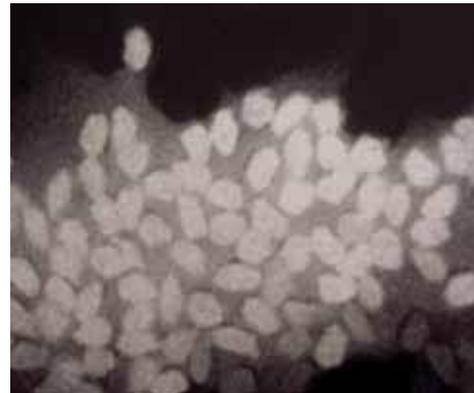


Figure 1b. The photograph shows a high resolution optical image cross-section of the Vertex™ TX59 100% polyester microdenier yarn. The filaments in white are whole and are unlikely to break into free particles and fibers.

The other part of the yarn definition is denier per filament (DPF), which is the denier divided by the number of filaments in the yarn bundle. The technical definition of microdenier yarn states that the DPF is less than one. For comparison, fine silk yarn is 1.25 DPF² and is therefore not a microdenier. Most standard polyester cleanroom wipers have a DPF of approximately 2. When comparing two wipers with the same denier, one having a DPF less than 1 and the other with a DPF of 2, the microfiber wiper has a greater surface area at the filament level. This higher surface area allows a microdenier wiper to capture more particles, remove more organisms, and sorb more liquid into the wiper.

Effectiveness of Microdenier Wipers

In the 1990s, hospitals started to use microfiber materials in cleaning applications. Five independent university studies in hospital settings compared the use of microdenier cleaning materials to more traditional cotton cleaning materials.^{3,4,5,6,7} All five studies came to the same conclusion: microdenier materials are superior to the traditional wipers when applying cleaning solutions and drying surfaces. The high sorptive capacity of the microdenier wiper (the ability to hold liquids in the wiper) allows for even distribution of a cleaning solution on surfaces; the first part of the surface receives the same amount of liquid as the last part of the surface being cleaned.¹

Even more remarkably, when microfiber wipers were used in a drying application, they removed up to 99.4% of microorganisms found on the surface compared to 30% for wipers containing cellulose.⁵ These same properties make microfiber wipers effective for:

- cleaning nano-sized particles (or nano-particles)⁸
- removing fingerprints and oils from PC monitors, TV or smart phone screens without leaving behind any streaks
- applying and removing liquids such as disinfectant solutions from surfaces⁹
- wiping a wet surface dry, unlike most synthetic wipers

Fibers Versus Small Particles

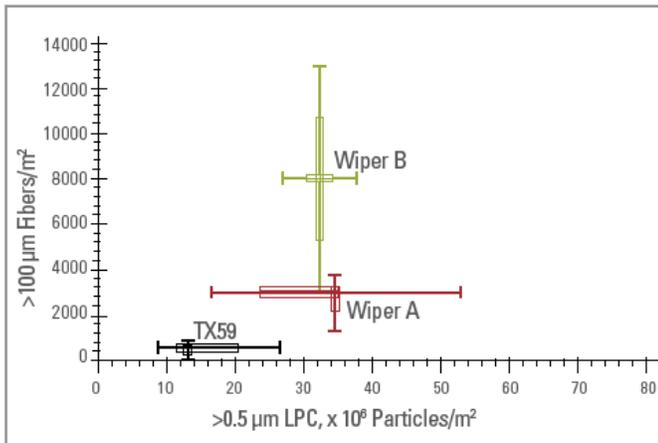


Figure 2. The chart shown is a consistency chart representation of the >100 μm fibers and the >0.5 μm particles measured by liquid particle counting (IEST-RP-CC004.3 biaxial shake). For each product, the medians of the box and whisker for each property intersect. The boxes each contain fifty percent of the data for each property. As the medians move toward the origin of the chart (bottom left), the product has fewer particles and fibers, indicating a cleaner product. As the boxes become smaller and the whiskers shorter, the product is more consistent. A good cleanroom wiper has properties nearer the origin, smaller boxes and shorter whiskers, signifying a cleaner and more consistent product. Vertex™ TX59 is a cleaner, more consistent product compared to Wiper A and Wiper B products.

This remarkable wiping performance of microdenier wipers can be directly attributed to the increased surface area of the filaments that make up the yarn bundle compared to filament surface area of standard synthetic wipers.

Cleanliness of microdenier wipers

In spite of their impressive performance in cleaning applications, microdenier wipers have traditionally proved difficult to clean. The same attributes that make a microfiber wiper effective at cleaning (tight construction pattern in the wiper and the increased filament surface area) also makes cleaning the wiper more challenging. The increased surface area of the filaments tends to retain the additives needed to manufacture the microfiber fabric.¹⁰ Traditionally, the surfactant level was increased to remove process additives; however, the extra surfactant is also captured in the fabric. The result is a wiper with elevated NVR (non-volatile residues), ions, and particulate burden. Further, the density of the microdenier fabric construction can make it difficult to obtain a consistently reproducible edge treatment, which can contribute to higher variability in particulate levels.

A key factor contributing to the traditionally lower levels of cleanliness of microdenier wipers is the use of a bi-component filament, commonly composed of 70% polyester and 30% nylon, although the blend ratio can vary. The two components are split during processing making for a lower DPF, but the resulting filaments are more fragile and, hence, more susceptible to further breakage. Filament splitting leads to higher particulate and fiber levels. Further, nylon is not compatible with the same chemicals as polyester which prevents the use of these bi-component microfiber wipers in some applications.

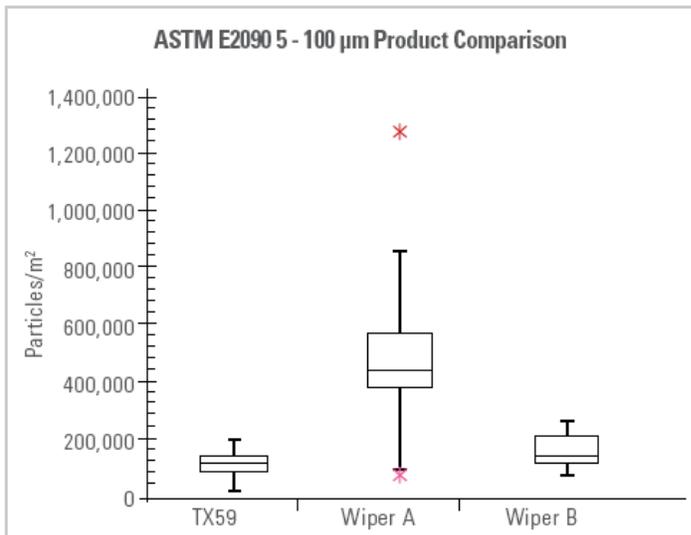
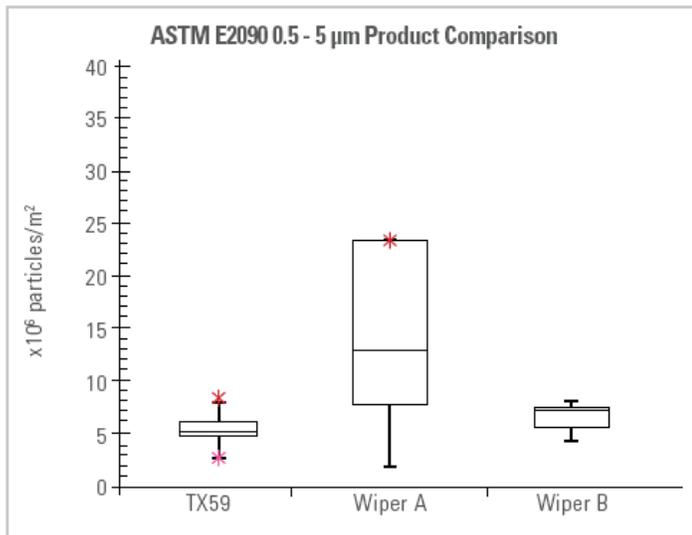


Figure 3. Consistency charts showing the different particle size ranges using scanning electron microscopy (SEM), comparing TX59 and Wiper A and Wiper B. The boxes each contain fifty percent of the data for each property. As the medians move toward the x-axis (bottom of chart), the product has fewer particles or fibers, indicating a cleaner product. As the boxes become smaller and the whiskers shorter, the product is more consistent. Vertex™ TX59 is a cleaner, more consistent product compared to Wiper A and Wiper B products.

The deficiencies of microdenier wipers for use in a critical clean environment have been addressed by using 100% polyester microfiber yarn in Texwipe's new Vertex™ wiper manufacturing process where rolls of fabric are cleaned, dried, cut, stacked, and packed in a HandsFree™ microenvironment. This new wiper, Vertex™ TX59 is cleaner and more consistent than any microdenier wiper currently used in cleanroom environments as illustrated in Figures 2 and 3. Texwipe's Roll2Bag™ manufacturing process cleans and seals the TX59 wipers so effectively, as to ensure that its tightly knit filament structure exhibits cleanliness levels that were not achievable in a microdenier wiper until Vertex.

Conclusions

Microdenier wipers present several advantages in their ability to clean surfaces when dry, consistently apply cleaning solutions to surfaces, and effectively remove microbial contamination from surfaces. Vertex™ TX59 has all of these advantages in addition to being the cleanest and most consistent microdenier wiper ever produced.

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