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W/B technologies. The membrane is waterproof but allows water vapor to pass through. A common misconception is that the spaces in the membrane are small enough to prevent water in liquid form to enter but large enough for water vapor to enter. This is not exactly true as the openings between the filaments are big enough for water to pass through!

The PTFE membrane surface is hydrophobic, or extremely water repellent. Water in liquid form has very strong intermolecular forces that are greater than the attractive forces between water molecules and the PTFE. Liquid water cannot pass through the PTFE membrane because it takes a great deal more pressure to force it through the openings than even the heaviest of rainstorms can generate. When PTFE membranes become contaminated with oil, dirt, detergent, and other chemical compounds, the surface cannot repel these contaminants. Although first generation Gore-Tex was initially effective at repelling water, the material leaked over time due to the formation of pore channels that wicked moisture through the fabric. Moreover, PTFE membrane alone is very delicate and is not durable enough for prolonged use without a backing fabric layer.

2. Expanded PTFE Membrane + PU (hydrophilic monolithic)

To prevent contaminants from compromising the performance of the PTFE-membrane, an additional membrane made of PU can be used to protect the PTFE surface. Since the PU membrane pores do not allow water (liquid or vapor) through, the PU is modified to be water absorbent (hydrophilic). Once water comes into contact with the PU membrane surface closest to the skin, individual water molecules are transported by solid state diffusion outwards. Diffusion is a process by which a substance at a high concentration is transported to a region of lower concentration. Thus individual water molecules in their liquid form travel through the PU driven by the high concentration of moisture on the inner surface of the membrane and the low concentration of water on the outer surface. Once the water molecule reaches the PTFE, it evaporates and is transported by gas phase diffusion through the PTFE membrane (see Figure 2). PTFE-PU membranes are also referred to as a hydrophilic monolithic membranes.
The PTFE-PU construction is used because the PTFE surface provides just the right amount of surface roughness to bond well with a very thin layer of PU so that surface imperfections (leakages) do not occur. The key difference between PTFE and PTFE-PU membranes is that PTFE-PU moves water at a much slower rate than the original PTFE. This rate is dependent in part on the thickness of the PU membrane: the thinner the membrane, the faster the rate of diffusion. Since thin membranes tend to be very delicate, a protective layer of polyester tricot is usually laminated to the inner surface of the PU membrane.

This particular construction is known as a 3-layer fabric and tends to be bulkier and heavier than other membrane technologies. Current Gore-Tex fabrics are constructed in this manner (Gore-Tex XCR® uses an extremely thin PU membrane).

3. PU-only membrane (hydrophilic monolithic)

Waterproof-breathable fabrics can also be made without the PTFE layer because the PU membrane is essentially responsible for the bulk of moisture transmission. PU that is laminated to other materials like nylon can be up to three times as thick as the PU layer that is laminated to PTFE. The PU thickness is significant because the WVTR is inversely proportional to the membrane thickness; the thinner the membrane, the faster water moves through it. The main differences between PU-only W/B fabrics are membrane thickness, base fabric that the PU is laminated against, and surface texture of the PU.

PU membrane constructions are more durable than PTFE-PU membranes so they do not need to be protected by an additional layer. This 2-layer construction tends to be lighter, more flexible, and more compressible. Without the additional PTFE layer, PU-only fabrics are also cheaper to manufacture.

4. Expanded PTFE + oleophobic properties (eVent®)

PTFE membrane can be engineered be oleophobic, which makes it resist to oily contaminants. Without the solid PU membrane to slow down water transmission, moisture moves much faster through the open spaces between the fibers. One such fabric that behaves in this manner is eVent®, manufactured by GE.

Although eVent® is one of the highest performing WP/B fabrics, there are a couple major drawbacks. Since the membrane is extremely delicate, the PTFE must be laminated to a protective liner which adds considerable weight and bulk. Perhaps more concerning is the cost of eVent®, which is many times that of its PU-only counterparts. Finally, GE has chosen not to make eVent® fabrics FR-compliant because FR treatments significantly decreases breathability of the fabric.
5. Microporous Polypropylene Laminate (3M Propore)

The construction of microporous polypropylene (PP) laminates consists of a W/B microporous PP membrane laminated to a nonwoven PP fabric or a W/B microporous PP membrane laminated between two nonwoven PP fabrics. Microporous PP laminates tend to be lighter and less expensive than eVENT and Gore-Tex XCR. Fabric weights also tend to be lighter than those of PU WP/B laminates. However, microporous PP are generally not durable and are especially prone to tears and punctures.

6. Hydrophobic Microporous WP/B Polyurethane (NEMO’s Osmo™)

A hydrophobic microporous polyurethane membrane has also been produced that has a similar moisture transport mechanism as expanded PTFE. Special manufacturing processes are used to create tiny holes and fissures in the polyurethane coating that allow water vapor to be transported freely out of the fabric. Much like PTFE, water cannot penetrate the fabric because water’s surface tension is extremely high. In independent laboratory tests, 2010 OSMO™ showed one of the highest breathability rates for tent fabrics.