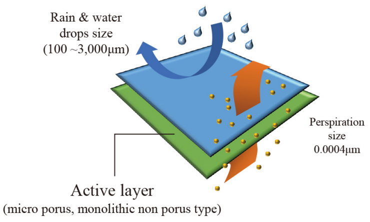
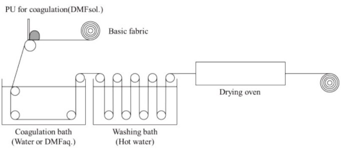
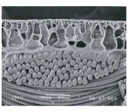
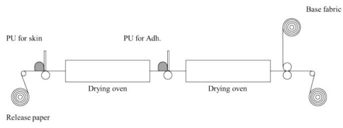
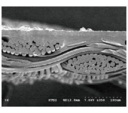
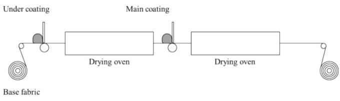
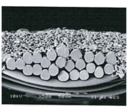
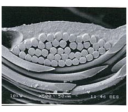
Climate responsive water-proof and breathable active coating technology

1. 透湿防水機能性素材の概念

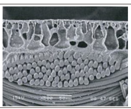
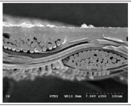
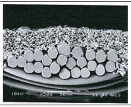
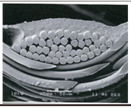
透湿性は、スポーツ活動中に肌から出る汗を水蒸気の形で排出させる繊維の能力であり、このように息づく機能を与えることで汗を体外に排出しやすく、肌は乾燥さを保つことで快適さが長持ちするようになる。排出メカニズムは、水蒸気分子が0.004um、雨粒が100-3000umの大きさなので、繊維素材に0.2-3.0umの微細多孔膜を作ると、外部の雨を防ぎ、汗を排出する製品の設計が可能である。このようなフィルムの素材はPTFE樹脂が使われているが、汎用的にはポリウレタン、ポリエステル樹脂などが多様なコーティング工法によって開発及び商品化され、機能性衣類製品の市場を形成している。



2. 主な生産プロセス

Process	Cross section	Examples of Performances
Wet process  PU for coagulation(DMFsol.) Basic fabric Drying oven Coagulation bath (Water or DMFaq.) Washing bath (Hot water)		Water permeability : 8,000g/m²/24h Water proofness : 8,000mmH_2O (>15,000mmH_2O)
Dry process – Transfer(Laminating) method  Base fabric PU for skin PU for Adh. Drying oven Drying oven Release paper		Water permeability : 6,200g/m²/24h Water proofness : >20,000mmH_2O
Dry process – Direct coating method  Under coating Main coating Drying oven Drying oven Base fabric		(Porous type) Water permeability : 7,000g/m²/24h Water proofness : 5,000mmH_2O (>15,000mmH_2O)
		(Non-porous type) Water permeability : 3,000g/m²/24h Water proofness : >10,000mmH_2O)

3. 主な生産プロセス

Process	Cross section	Advantage	Disadvantage	Remarks
Wet Process		• Soft and rich feeling • High permeability • Strong surface • Solvent; DMF only (recyclable)	• Slower line speed • Special equipment for the system • Less water proofness	
Transfer Coating (Lamination)		• Light and thin • High permeability • High water proofness • High peeling strength • Faster line speed	• Less volume • Less permeability • Mixed solvent • Using release paper	
Direct Coating Micro porous		• Soft and rich feeling • High permeability • High breathability • Simple equipment	• Resin handling (High volatility) • Less water proofness • Mixed solvent	
Non-porous		• Light and thin • Easy process • Faster line speed • Cheaper cost	• Less volume • Less permeability • Less water proofness •	

4-1. 透湿度測定法

試験概要

透湿度は、主に繊維素材において、水蒸気形態の汗を衣服の外部に放出させる性能について評価する試験であり、衣類製品の快適性を評価する代表的な機能性試験項目の一つである。

標準試料量

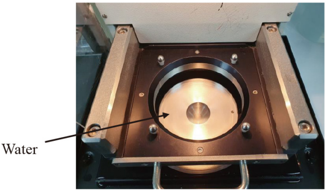
全幅　×　30cm以上

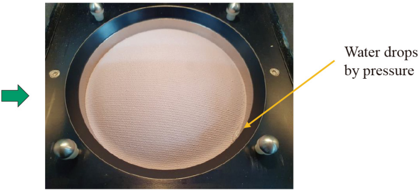
測定装置

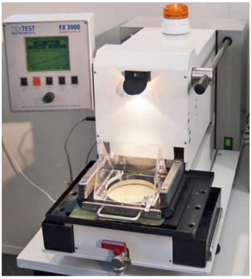
4-2. 国別透湿度測定法

	Test Method	Measurement Principle	Temperature	Humidity	Desiccant	Distance between Desiccant and Test Specimen Bottom	Wind Speed	Grammage Interval	Evaluation Items	Unit
South Korea / Japan	KSK 0594 JIS L 1099-99 A-1	Calcium Chloride Method	40± 2℃	90± 5%RH	Calcium chloride	3mm	0.8m/s less	1 hours	Water vapor permeability	$\mathrm{g/m^2 \cdot h}$
	JIS L 1099-99 A-2	Water Method	40± 2℃	50± 5%RH	Measurement of water evaporation	10mm		1 hours	Water vapor permeability	$\mathrm{g/m^2 \cdot h}$
	JIS L 1099-99 B-1	Potassium Acetate Method	30± 2℃	23℃	Potassium acetate solution	Test specimen submerged in approximately 10mm of water	–	15 minutes	Water vapor permeability	$\mathrm{g/m^2 \cdot h}$
	JIS L 1099-99 B-2	Potassium Acetate Method	30± 2℃	23℃	Potassium acetate solution	Test specimen submerged in approximately 10mm of water	–	15 minutes	Water vapor permeability	$\mathrm{g/m^2 \cdot h}$
United States	ASTM E96 A	Calcium Chloride Method	23℃(73.4℉)	50± 2%RH	Calcium chloride	6mm	0.02~0.3m/s	No specific regulations. (However, measurements are taken at regular intervals, and the water vapor permeability and water vapor permeability coefficient are calculated from the elapsed time during which mass changes linearly.)	Water vapor transmission rate (WVT) anvd water vapor permeability coefficient	$\mathrm{g/m^2 \cdot h}$ $\mathrm{g/Pa \cdot s \cdot m^2}$
	ASTM E96 B	Water Method	23℃(73.4℉)		Measurement of water evaporation	19± 6mm				
	ASTM E96 BW	Reverse Water Method	23℃(73.4℉)		Measurement of water evaporation	6mm				
	ASTM E96 C	Calcium Chloride Method	32.2℃(90℉)		Calcium chloride	19± 6mm				
	ASTM E96 D	Water Method	32.2℃(90℉)		Measurement of water evaporation	10± 1mm				
	ASTM E96 E	Calcium Chloride Method	32.8℃(100℉)		Calcium chloride	6mm				
United Kingdom	BS 3424-34	Water Method	20± 2℃	65± 5%RH	Measurement of water evaporation	10± 1mm	6m/min	Less than 16 hours	Water vapor permeability (WVP)	$\mathrm{g/m^2 \cdot 24h}$
	BS 7209								moisture permeability index (WVPI)	%
Germany	DIN 53122-1 A Atmosphere	Calcium Chloride Method	25± 1℃	90± 2%RH	Calcium chloride or silica gel	3~4mm	Not specified (inside desiccator)	Water vapor permeability of the sample is measured at intervals of 24 hours, 24 hours, 48 hours, 72 hours, and 96 hours.	Water vapor permeability (WDD)	$\mathrm{g/m^2 \cdot h}$
	DIN 53122-1 B Atmosphere (For rubber sheeting)		38± 1℃	90± 2%RH						
	DIN 53122-1 C Atmosphere		25± 1℃	75± 2%RH						
	DIN 53122-1 D Atmosphere (For film and laminate paper)		23± 1℃	85± 2%RH						
	DIN 53122-1 E Atmosphere (For paper and cardboard)		20± 1℃	85± 2%RH						
ISO	ISO 15496	Potassium Acetate Method	30± 2℃	23℃	Potassium acetate solution	Test specimen submerged in approximately 10mm of water	–	For 15 minutes	Water Vapor Permeability (WVP)	$\mathrm{g/m^2 \cdot Pa \cdot h}$
	ISO 11092	Sweating Guarded Hot Plate Method	20℃	65%RH	–	–	1m± 5cm/sec	–	For paper and cardboard	$\mathrm{m^2 \cdot K/W}$

4-3. 耐水圧の測定実験例







ISO 811 (Low hydrostatic pressure test)
Pressure increase rate; (60± 3)cmH_2O/min
Valid for < 20,000mmH_2O

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The pressure at the point which measuring person sees 3 water drops