HIROSE PAPER MANUFACTURING CO.,LTD.

Hirose Paper is an innovative Japanese nonwoven company which has over 50 years of history of making wet-laid nonwovens using synthetic fibers. Our goal is to create high performance wet-laid nonwovens for our customers who are developing future industrial materials, innovative technologies and new products.

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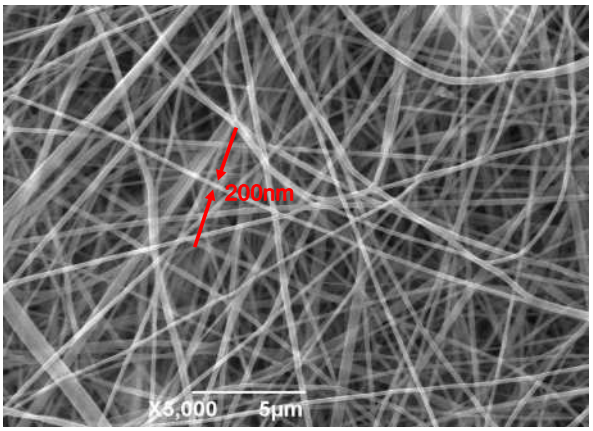
Hirose Paper's Technology

Wet-laid nonwoven: Hirose Paper is known for the high performance nonwoven products. We make full use of various synthetic fibers and wood pulps to achieve customers' product performance specifications. We can control the basis weight between 2 and 100 g/m^2 while maintaining uniformity at very high level. Our distinctive technology allows us to produce the world thinnest nonwoven of 2 g/m^2. Our technology is also flexible: suitable for the low volume, custom-made materials you may want while developing a product as well as the large volumes you would need once your product was launched.

Nanofiber: Hirose Paper has recently developed a nozzle-free electrospinning technology that can achieve low cost, high speed, continuous spinning of nanofibers. For this invention, we were awarded the Innovation Prize from the Japanese Ministry of Economy, Trade and Industry. We have developed Lithium ion battery separators by applying this technology. This nanofiber can also be used for various filter materials. We are seeking additional applications for this technology.

Ultrathin wet-laid nonwoven

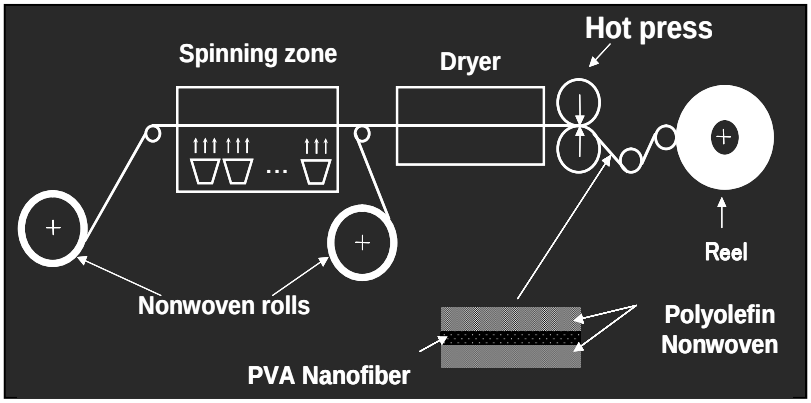


Nozzle-free electrospun PVA nanofiber

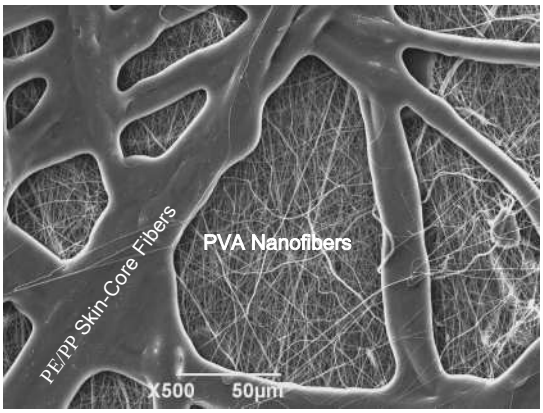
Nanofiber Technology

Hirose Paper has established production technology of a high performance Lithium ion battery (LIB) separator using advanced electrospinning of nanofibers. Conventional electrospinning of nanofibers is costly since it requires multiple-nozzle set-ups to improve mass production. The nozzle-free method we invented can achieve high speed and continuous spinning of nanofibers at low cost.

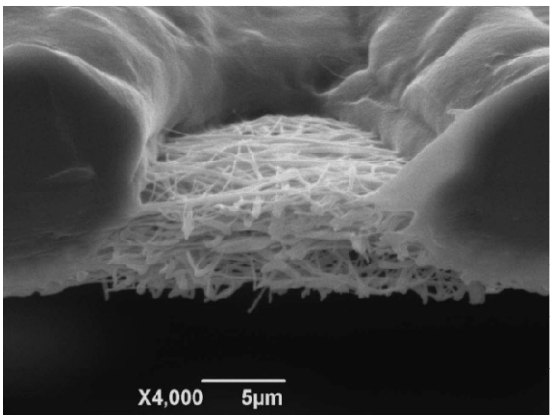
The web of nanofibers by itself is hard to use as a battery separator because of its extremely low stiffness. We solved this problem by spinning nanofibers onto the surface of low basis weight wet-laid nonwovens. Hirose Paper 's ultra-thin nonwovens, which are as thin as 6 g/m^2, are ideal for backing a layer of nanofibers. For the LIB separator application, PE/PP fiber based nonwoven is used as the backing layer and PVA nanofibers are spun on it. It is also possible to produce a separator which has a nanofiber layer sandwiched between two nonwoven layers. The nanofiber based separator is considerably thinner than the conventional polyethylene-based separator, and its thickness can be precisely controlled in the15-30 µm range. The diameter of nanofibers is about 200 nm. Average pore size of the separator can be controlled in the rage of 500 nm to a few µm. The advantage of PVA nanofibers is their high melting point. The meltdown temperature of the nanofiber-based separator is over 200 ºC which is significantly higher than that of polyethylene-based separator.



LIB separator production process



Surface of LIB separator (nonwoven side)



Cross section of LIB separator

Polyester Wet-laid Nonwoven (Type TH)

Type TH is a wet-laid nonwoven of 100% polyester. Hot calendering treatment melt fibers to form bonding. Type TH includes three grades: low density 15TH; high density 05TH; and ultra-high density H. Type TH has excellent dimensional stability against heat up to 200 ºC. It also offers good resin impregnation. Type TH can be a base material for various industrial applications.

Features	Applications
• High strength (dry and wet) • High heat resistance • High water resistance • Good printability • High electrical insulation • Good formability • High chemical resistance • High weather resistance • Flexible • High dimensional stability	• Food wrapping • Filters (water, oil, air) • Heat resistance materials • Water resistance materials • Printing papers • Paper patterns, padding • Tape base cloths • Insulation materials • Impregnation base cloths • Wipers • Other industrial materials

Vinylon Wet-laid Nonwoven (Type VN)

Type VN is an unique wet-laid nonwoven made of vinylon fiber. Vinylon is a synthetic fiber spun from PVA. The fiber was invented in Japan and is grown world-wide. Vinyl is the American name for vinylon. Vinylon is the only hydrophilic and hygroscopic synthetic fiber which has a texture similar to that of cotton. Vinylon fiber has excellent properties, such as high strength, good abrasion resistance, and good heat rersistance. It is also resistant to degradation by chemical corrosion, sunlight, moth, mold, and radiation. Two types of vinylon fibers are used to make wet-laid nonwoven: soluble vinylon binder fibers and scarcely-soluble vinylon fibers. After the wet web is formed on the paper machine and dewatered, these fibers form strong bonds while being heated on the Yankee dryer surface.

Features	Applications
• High tensile strength • Very tough • High abrasion resistance • High alkali resistance • High oil resistance • High corrosion resistance • High heat resistance	• Alkaline battery separator • Plywood reinforcing materials • Construction materials

Physical Properties Type TH

TYPE	Basis weight g/m²	Thickness μm	Density g/cm²	Tensile strength kg/15mm				Elongation %				Tear strength g/16 sheets		Air permeability
				Dry		Wet		Dry		Wet				
				MD	CD	MD	CD	MD	CD	MD	CD	MD	CD	sec/100cc /sheet
05TH-08	7.61	38	0.200	0.32	0.09	0.24	0.07	3.1	5.2	3.0	5.9	15	24	0.10
05TH-12	12.1	43	0.281	0.97	0.31	0.91	0.29	6.5	8.9	6.2	10.9	30	62	0.10
05TH-15	14.2	41	0.346	1.30	0.54	1.33	0.49	7.1	10.0	6.7	9.5	22	42	0.10
05TH-20	20.0	72	0.278	1.26	0.31	1.08	0.28	3.9	4.5	3.0	2.9	52	86	0.13
05TH-24	23.1	60	0.385	3.02	1.19	2.79	1.14	8.8	11.6	8.0	11.0	24	48	0.13
05TH-36	35.4	80	0.443	4.10	2.52	4.05	2.44	10.3	13.2	10.1	13.7	34	44	0.13
05TH-48	47.9	96	0.499	6.08	2.98	5.73	2.55	11.5	14.6	10.3	12.9	80	95	0.16
05TH-60	58.6	119	0.492	7.35	4.24	7.05	3.80	11.9	13.9	12.8	12.6	70	89	0.20
05TH-80	82.0	145	0.566	9.55	6.62	8.23	5.51	11.8	14.0	11.8	12.3	167	208	0.36
05TH-100	99.8	161	0.620	10.10	6.51	6.37	4.50	9.0	11.7	7.0	7.9	328	308	0.50
15TH-15	15.5	42	0.369	0.736	0.214	0.532	0.188	2.7	3.6	2.2	5.0	32	60	-
15TH-24	23.2	71	0.327	2.42	0.97	2.30	0.95	6.1	11.6	7.0	12.4	25	60	0.10
15TH-36	34.5	87	0.397	4.69	1.44	4.49	1.26	10.6	13.1	10.7	11.8	58	77	0.13
15TH-60	59.5	129	0.461	4.42	2.54	3.46	1.93	7.0	10.1	5.5	7.5	160	214	0.16
15TH-80	78.5	170	0.462	7.97	7.19	5.59	3.01	14.9	18.5	9.8	9.2	244	252	0.16
15TH-100	101.3	183	0.554	7.93	5.12	5.80	3.85	12.2	11.3	7.9	6.8	304	424	0.26
15TH-145	142.6	283	0.504	13.20	8.18	11.50	6.83	13.2	14.4	11.4	12.4	720	880	0.26
05TH-20H	19.8	45	0.440	2.06	3.74	2.19	0.73	5.9	13.6	6.1	10.6	12	21	0.13
05TH-40H	37.8	75	0.504	4.92	2.07	4.13	2.32	9.8	13.3	8.0	12.1	30	38	0.13
05TH-80H	78.5	124	0.633	9.35	2.44	8.88	4.84	12.5	13.3	12.1	16.1	76	102	0.43
05TH-100H	97.4	157	0.620	11.50	5.28	10.50	5.68	15.4	15.9	15.9	14.7	162	208	0.43

Physical Properties Type VN

TYPE	Weight g/m²	Thickness μm	Density g/cm²	Tensile strength kg/15mm				Elongation %				Tear strength g/16sheets		Air permeability	
				Dry		Wet		Dry		Wet					
				MD	CD	MD	CD	MD	CD	MD	CD	MD	CD	cc/cm²·sec	sec/100 cc /sheet
VN1012	11.8	50	0.236	1.12	0.49	0.17	0.06	4.0	3.9	1.9	1.9	21	44	191.0	0.10
VN1024	25.2	91	0.277	4.15	1.63	0.94	0.36	6.6	6.2	4.2	3.8	50	82	66.2	0.13
VN1036	36.4	119	0.306	7.22	3.36	1.16	0.64	8.1	8.1	5.0	5.4	62	68	37.1	0.16
VN1048	47.4	156	0.304	8.45	5.19	1.65	1.05	7.5	7.9	5.1	4.8	102	138	29.0	0.16
VN1060	60.6	203	0.299	13.10	6.22	2.59	1.31	8.4	8.1	5.5	5.9	128	164	28.8	0.20
VN1084	84.8	253	0.335	15.30	12.00	2.99	2.56	8.8	9.1	6.2	6.5	166	200	-	0.43
VN10100	99.3	302	0.329	20.50	11.20	4.06	2.26	9.2	9.0	5.7	5.8	219	284	-	0.30

Polyolefin Wet-Laid Nonwoven (Type HOP)

Type HOP is a wet-laid nonwoven made of 100% polyolefin fiber. The polyolefin fiber is PE/PP skin-core fiber in which the PE layer on the outer surface melt on the Yankee dryer surface to form strong bonding. No bonding agents are used. HOP includes two types: double-layer type 2P for low temperature heat seal and single-layer type H. The seal temperature of type 2P is 110ºC and that of type H is about 140ºC. Since fibers are bonded by the heat treatment without bonding agents, HOP can be used for food wrapping and for other medical packaging uses.

Features	Applications
• Heat sealable • High oil absorption • Good for heat forming • High chemical resistance • Good insulator • High electrical resistance	• Waterproof sheet for medical use • Sterilized paper • Bags for desiccant and deodorants • Base paper for chemical processing

Polyester/Polypropylen Wet-Laid Nonwoven (Type EP)

Conventional heat seal materials are made of cellulose fibers such as pulp and Manila hemp. These materials require addition of wet-strength reinforcing agents or application of PVA before use in water. However, these added chemicals are water-soluble and will leach into the water. Type EP is a wet laid nonwoven fabric of 100% synthetic fiber with two layers of polyester and polypropylene, which was first developed by Hirose Paper. It has excellent heat seal properties: neither chemicals nor PVA are needed. Accordingly, it is excellent as a food wrapping material.

Features	Applications
• High heat seal strength • Wetting does not lower paper strength • Excellent structural integrity while immersed • Strength retained in boiling water • Tasteless and odorless • Good printability • No chemicals needed for heat sealing • No strength aids to leach into solution	• Coffee filters • Bags for bath powders and aromatics • Tea bags • Bags for desiccants • Cooking bags for stocks • General wrapping/packing materials

Physical Properties Type HOP

TYPE	Weight g/m²	Thickness μm	Density g/cm²	Tensile strength kg/15mm				Elongation %				Tear strength g/16sheets		Air permeability	
				Dry		Wet		Dry		Wet					
				MD	CD	MD	CD	MD	CD	MD	CD	MD	CD	cc/cm²·sec	sec/100cc /sheet
HOP-6				0.75	0.39	-	-	9.4	16.5	-	-	-	-	-	-
HOP-10H	9.8	42	0.231	0.70	0.52	-	-	-	-	-	-	-	-	398<	0.10
HOP-15H	15.2	63	0.223	1.32	0.77	1.28	0.74	22.7	21.7	25.0	19.4	26	35	327.0	0.10
HOP-30H	29.3	110	0.266	3.07	1.71	3.00	1.65	25.1	24.5	29.6	25.4	39	48	120.0	0.13
HOP-40H	42.5	183	0.232	3.61	2.43	-	-	-	-	-	-	-	-	-	-
HOP-50H	48.5	170	0.285	4.48	2.75	4.21	2.70	27.6	29.1	36.5	30.5	66	86	98.1	0.13
HOP-60H	59.7	228	0.261	3.88	5.69	-	-	-	-	-	-	-	-	70.5	-
HOP-80H	79.7	291	0.273	4.90	7.64	-	-	-	-	-	-	-	-	28.8	-
HOP-2P30	30.0	100	0.300	2.33	1.09	1.76	1.06	20.3	21.5	21.4	19.0	43	50	108.0	0.13
HOP-2P50	47.5	140	0.399	3.95	2.03	3.80	2.00	34.0	37.0	36.8	36.8	54	68	-	0.13

Physical Properties Type EP

TYPE	Weight g/m²	Thickness μm	Density g/cm²	Tensile strength kg/15mm				Elongation %				Tear strength g/16sheets		Air permeability	
				Dry		Wet		Dry		Wet					
				MD	CD	MD	CD	MD	CD	MD	CD	MD	CD	cc/cm²· sec	sec/100 cc /sheet
05EP-16	16.8	58	0.289	1.03	0.35	0.85	0.32	7.3	9.8	7.0	8.0	22	46	-	0.10
05EP-26	26.3	74	0.355	1.84	0.89	1.65	0.86	9.4	12.4	8.5	9.5	37	51	124.0	0.13
05EP-35	34.6	95	0.364	2.25	1.50	1.88	1.14	9.9	12.9	10.2	9.7	38	52	54.4	0.13
05EP-50	48.2	112	0.430	4.31	2.06	3.40	1.98	11.5	13.4	10.7	12.5	44	58	27.8	0.16
15EP-26	25.9	86	0.301	1.98	0.55	1.45	0.46	10.1	10.5	6.3	8.3	46	108	155.3	0.13
15EP-35	35.0	100	0.350	2.41	1.16	1.93	0.92	11.1	11.1	7.5	8.8	64	128	96.6	0.13
15EP-50	50.1	120	0.417	4.53	1.99	3.14	1.72	14.2	13.8	11.3	12.2	86	140	44.6	0.13

Wet-Laid Nonwoven for Food Wrapping (Type HOS)

Type HOS is a wet-laid nonwoven developed for food wrapping. HOS includes two types. The standard type is 100% polyester fiber based nonwoven laminated by polyethylene layer; type P is a mixture of wood pulp and polyester fiber without lamination. These types are excellent as food wrapping materials since binders such as PVA and other chemicals are not used. Analysis of extractives shows that heavy metal content as well as solvent and water extractives are below recommended levels. HOS of 100% polyester has good printability. It shows good strength in dry and in wet conditions and can be used even in the boiling water. All of them are the heat-seal types.

Features	Applications
• Good for printing • Good strength (dry and wet) • Heat sealable • No contamination of food with direct contact	• Wrapping/packing paper for foods

Physical Propeties Type HOS

TYPE	Weight g/m^2	Thickness μm	Density g/cm^2	Tensile strength kg/15mm				Elongation %				Tear strength g/16sheets		Air permeability	
				Dry		Wet		Dry		Wet					
				MD	CD	MD	CD	MD	CD	MD	CD	MD	CD	$cc/cm^2 \cdot sec$	sec/100cc /sheet
HOS-2415	35.2	60	0.586	2.56	1.64	2.66	1.54	8.6	11.9	9.2	12.1	29	68	0.41≧	-
HOS-3015	42.9	73	0.587	4.52	2.46	4.04	2.60	8.8	13.2	9.2	13.5	42	70	0.41≧	-
HOS-3615	50.1	83	0.603	4.83	2.87	4.28	2.61	10.2	12.5	9.7	11.5	59	82	0.41≧	-
HOS-16P	15.4	82	0.187	0.41	0.13	0.31	0.07	2.6	4.0	11.6	12.2	45	90	-	0.13
HOS-30P	31.3	101	0.310	2.24	0.76	1.50	0.47	3.3	2.7	8.6	10.0	24	64	27.7	0.26