Nano Cellulose
Cellulose Nano Fiber (CNF)

Nano Cellulose, Cellulose nanofiber (CNF) has the size of 4-20 nm in width and several micrometer in length with large aspect ratio. Weight of cellulose nanofiber is approximately 1/5 of iron steel although possess 7-8 times strength of iron steel. Thermal expansion coefficient is as small as glass fiber whereas elasticity modulus is higher than that of glass fiber (meaning hard, strong and robust material). Cellulose nanofiber is made of plant, tree and woods based biomass therefore very recyclable and biodegradable. They can be synthesized from most kind of woods based biomass resource so that raw material is very abundant, and can be cheap.

Therefore, cellulose nanofiber is the excellent green nano materials for the next generation future and research and development have been going on very actively in the world.

1. Strong and light weight

Weight of cellulose nanofiber is approximately 1/5 of iron steel although possess more than 5 times strength of iron steel which is even close to the physical property of carbon nanofiber.

Therefore, cellulose nanofiber is mixed with resin, thermoplastic etc… and can be applied to parts of automotive, airplane and architecture which would results in much of weight and energy saving.

2. Transparent

Cellulose nanofiber is basically chemically and physically untangled plant fiber. So that one of the fibers has the diameter only in 4 – 20 nm Cellulose nanofiber can be mixed into transparent resin such as acryl, epoxy resin to be reinforced while maintaining its transparency since

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the size of cellulose nanofiber is much smaller than visible light wavelength range (400-800 nm)

3. Low Thermal Expansion Coefficient

Cellulose nanofiber will not expand even under high temperature so that can be used to increase the viscosity of such products as cosmetics, also can be replacement of glass.

4. Huge quantity of material resource

Cellulose nanofiber is made from woods, trees, plant based biomass materials so that material resource is huge, and c an be economically cheap in the end.

5. Economically friendly and cheap.

Because of huge material resource, price can be cheap after all.

6. Recyclable and biodegradable

Because cellulose nanofiber is made from all natural resources, they are very recyclable and biodegradable, very environmentally friendly.

7. Other features

High absorbing ability

High surface area

Edible

Biocompatible.

8. Application

A. Mix with plastic, resin (can be applied to parts for car, automotive, airplane, architecture etc…)

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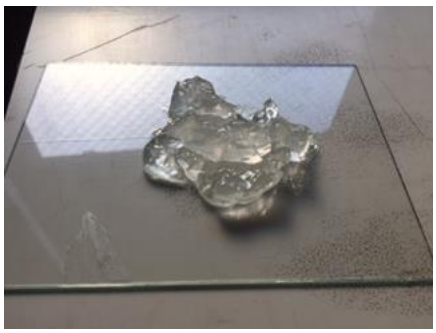
B. Strengthen various types of plastic, resin, thermoplastic while weight can be lighter
C. Filter
D. Transparent thin conductive thin film for EL display, Solar cell
E. Separator for lithium ion battery
F. Support body for catalyst
G. Artificial blood vessel, ligaments (Bio medical use)
H. Food additive
I. Cosmetic products
J. Smoothing, reinforcing for paper

CNF dispersion in water



CNF dispersion in Phenyl Glycol

CNF	0.2 - 10 %
Additive and Resin	0.01 - 1 %
Water	89 - 99.9 %
Viscosity	1.0 – 300000 mPa･s/ 25 °C
CNF size	20 - 500 nm

We can supply you in the form of cellulose nanofiber (CNF) in water dispersion. Also, we can make CNF dispersion in various type of organic solvent. Please consult with us which solvent you need such as alcohol, glycol ether based solvent, NMP, MEK, ethyl acetate etc… For example, below table indicates the basic property of CNF dispersion in water.

We also supply CNF composite materials mixed with various type of resin although trying to develop to mix higher CNF concentration.

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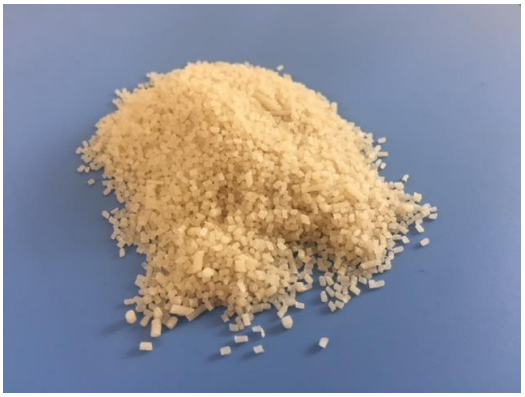
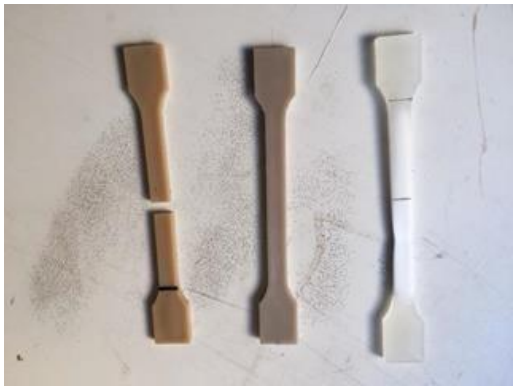
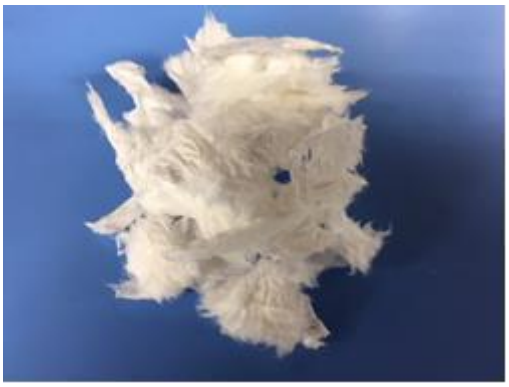


CNF mixed PLA (Poly Lactic Acid) Compounds



CNF mixed Plastic test pieces



Chemically modified Cellulose

Below table indicates the basic physical properties of our CNF composite masterbatch with various type of resin.

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Petroleum based Resin + Nano Cellulose Composite 1

Type of Petroleum based Resin	CNF Concentration (%)	Tensile Strength (MPa)	Tensile Stroke (mm)	Elasticity (MPa)	Bending Strength (MPa)	Bending Stroke (mm)	MFR (g / 10min.)	Charpy impact test (KJ/m2)
Low Density Polyethylene (LDPE)	0	10					6	
LDPE composite with CNF	23	15 - 17						
LDPE composite with CNF	33	24 - 25					2.4	
Linear Low Density Polyethylene (LLDPE)	0	14.4	135	472	11	15.9		
LDPE composite with CNF	20	24.8	8	1417	26.2	13.7		
Polypropylene (PP)	0	32	6.2 - 7.1	1800 - 1900	59.4	9.4	20 - 21	
PP composite with CNF	23	38 - 39	3.8 - 5.2	2600 - 3200				
PP composite with CNF	33	41 - 42						
PP composite with CNF	40	48 - 49		3400	80.3	7.7	2.1 - 2.5	
Poly Styrene (PS)	0	29						
PS composite with CNF	23	36 - 37						
Polymethyl methacrylate	0	42						
PMMA composite with CNF	23	56 - 57						
Polyamide 6 (PA6)	0	42					24 - 25	
Polyamide 6 (PA6) composite with CNF	13	53 - 79	7.1 - 8.9	3200 - 3300	95 - 96	10.5 - 11.2	21 - 22	33 - 34
Poly Vynil Chloride (PVC)	0	12						
PVC composite with CNF	23	22 - 23						

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GS TECHNICAL INFORMATION

Petroleum based Resin + Nano Cellulose Composite 2

Type of Petroleum based Resin	CNF Concentration (%)	Tensile Strength (MPa)	Tensile Stroke (mm)	Elasticity (MPa)	Bending Strength (MPa)	Bending Stroke (mm)	MFR (g / 10min.)	Charpy impact test (KJ/m2)
Acrylonitrile butadiene styrene	0	43	3	1600 - 1700				
ABS composite with CNF	23	50 - 55	2.9 - 3.0	2900 - 3300	66 - 67	5.4 - 5.8		
Polycarbonate (PC)	0	49	3.6	1907				
PC composite with CNF	23	70	3.8	3137				
polyvinyl butyral (PVB)	0	44						
PVB composite with CNF	23	54 - 55						
Thermoplastic Poly Urethane	0	25			2.5	23.2		
TPU composite with CNF	30	32	29	686	18.3	15.4		
polyacetal, polyoxymethylene	0	52	4.4 - 6.1	2000 - 2200				
POM composite with CNF	23	68 - 72	3.4 - 4.3	3900 - 4100	100 - 102	9.1 - 9.9		
Ethylene α Olefin Copolymer	0	7.3		22.7	1.5			
Ethylene α Olefin Copolymer with	33	7		370	6.7			
ethylene vinyl acetate (EVA)	0	6	273	43.5	2.8	20.7		
EVA composite with CNF	30	12	14	286	9.7	18		

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Biodegradable Resin + Nano Cellulose Composite

Type of Biodegradable Resin	CNF Concentration (%)	Tensile Strength (MPa)	Tensile Stroke (mm)	Elasticity (MPa)	Bending Strength (MPa)	Bending Stroke (mm)	MFR (g / 10min.)	Charpy impact test (KJ/m2)
polycaprolactone (PCL)	0	2						
PCL composite with CNF	23	8.5						
starch based plastic	0	8					42 - 52	
starch based plastic composite with CNF	23	19.5						
starch + PBAT based plastic	0	11	198	258.7				
starch + PBAT based plastic composite with CNF	25	24	4.2	1640				
								16 - 18
starch + PLA based plastic	0	29	2.4	1869	42.7	4.8		
starch + PLA based plastic composite with CNF	23	34	1.3	3567	59	3		
Poly buthylene succinate (PBS)	0	38	7.1 - 8.8	660 - 680	31	14		
PBS composite with CNF	26	48			52	12		
Poly Lactic Acid (PLA)	0	62	2.8	2831	98	7.4	62 - 78	
PLA composite with CNF	23	70	3.4	3800	117	4.8	13- 15	35 - 36
poly(butylene adipate-co-terephthalate) (PBAT)	0	12						
PBAT composite with CNF	23	18.5						
polyhydroxyalkanoate (PHA)	0	16						
PHA composite with CNF	30	24.5						

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Biodegradable Resin + Wood, Waste Wood, Paper, Waste Paper, Nano Cellulose Composite

Type of Biodegradable Resin	CNF Concentration (%)	Tensile Strength (MPa)	Tensile Stroke (mm)	Elasticity (MPa)	Bending Strength (MPa)	Bending Stroke (mm)	MFR (g / 10min.)	Charpy impact test (KJ/m2)
Starch based Biodegradable Resin	0	12					42 - 52	
Starch based Biodegradable Resin Composite with CNF	23	23 - 24						
Cellulose based Biodegradable Resin		40 - 44	2.1 - 3.8	2300 - 2400	45 - 48	5.1 - 5.4		
Cellulose based Biodegradable Resin Composite with CNF	23	50 - 51	3.9 - 4.8	3000 - 3100	47 - 50	7.9 - 8.1		
Cellulose based Biodegradable Resin Composite with Wood, Waste Wood	10	45 - 48	4.2 - 4.9	2500 - 2600	41 - 44	7.4 - 7.9		
Cellulose based Biodegradable Resin Composite with Paper, Waste Paper	23	46 - 49	4.8 - 4.9	2600 - 2700	44 - 46	7.5 - 8.2		
PLA Composite with Paper, Waste Paper	40 - 50	58 - 62	1.9 - 2.6	3400 - 3500	73 - 79	2.6 -2.9		
PLA Composite with Paper, Waste Paper and CNF	50 - 55	64 - 66	2.3 - 2.4	3600 - 3700	75 - 81	2.3 - 2.8		
PHBV Composite with Paper, Waste Paper	35	26 - 29	1.4 - 1.9	2900 - 3000	53 - 54	2.9 - 3.1		
PHBV Composite with Paper, Waste Paper and CNF	38 - 45	29 - 32	1.7 - 2.0	3000 - 3100	55 - 56	3.1 - 3.3		
PHBV Composite with Wood, Waste Wood	10.5	30 - 32	1.8 - 2.4	2700 - 2800				

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Recycle Plastic (Plastic Waste) + Nano Cellulose Composite

type of waste plastic (recycle plastic)	CNF Concentration (%)	Tensile Strength (MPa)	Tensile Stroke (mm)	Elasticity (MPa)	Bending Strength (MPa)	Bending Stroke (mm)
polypropylene (PP) from plastic pallet (Black color)	0	21.8	6.4	1304	31.6	8.4
PP composite with CNF	40	32.4	4.1	2851	51.7	7
polyethylene (PE) from diaper (from factory, white color)	0	11.7	5.2	1239	14.3	16.4
PE composite with CNF	30	33.8	4.3	2958	46.3	9.4

In general, tensile strength, bending strength, elasticity will increase by making nano cellulose composite. In contrast, MFR (Melt Flow Rate), impact strength decreases. Moreover, heat endurance increases a little (data not shown).

In addition, crystallinity, foaming property, molding property increases. We will keep improving resin properties and more data will be added to above data later on.

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