

Transparent piezoelectric film (under development)

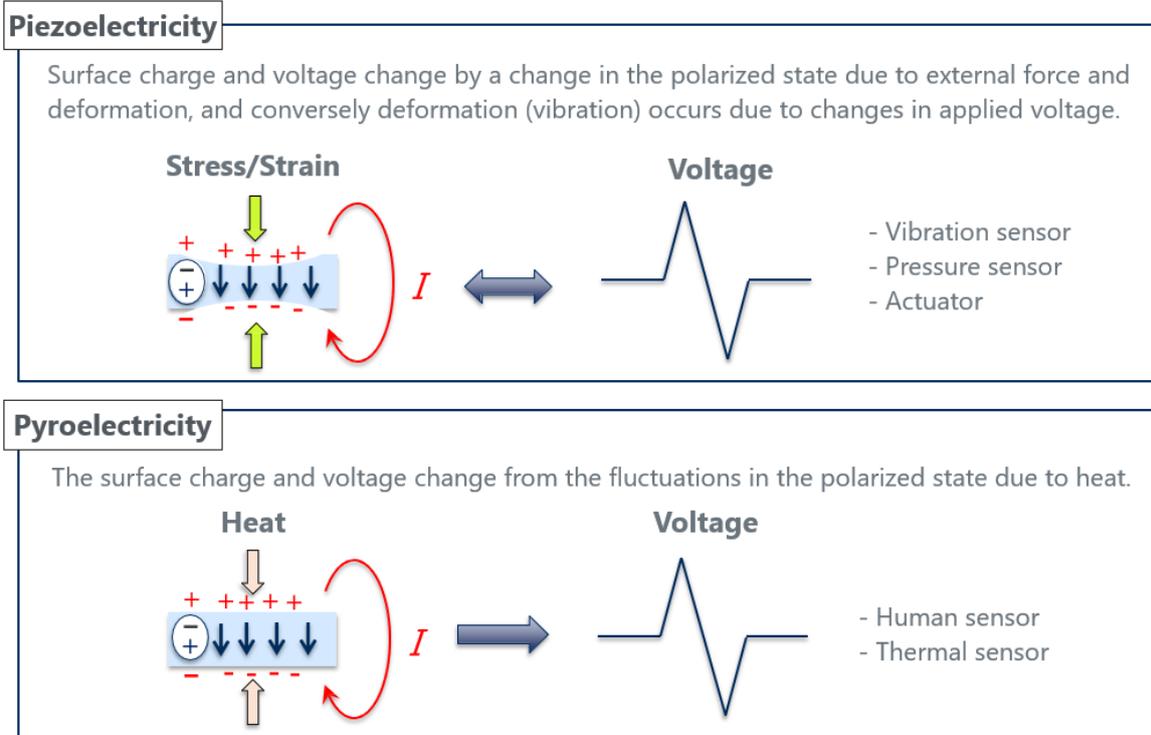
PRODUCT
INFORMATION

The new transparent piezoelectric film developed by Daikin features a unique property called ferroelectricity that converts force, strain, temperature change, and electrical energy in both directions. Additionally, because of its excellent transparency and flexibility, it is expected to become a key material for pressure-sensitive touch panels and wearable devices.

What is ferroelectric material?

This is a material that can maintain a polarized state (+/-) with no electric field by voltage processing and has both piezoelectricity (stress/deformation and electric signal conversion) and pyroelectricity (temperature change and electric signal conversion).

Fig.1 Ferroelectricity (piezoelectricity and pyroelectricity)



Solution

In addition to applications as optical film benefiting from its high optical characteristics (high transparency, low haze, and low birefringence), Daikin's transparent piezoelectric film is uniquely suited for various piezoelectric and pyroelectric applications with use expected in applications including pressure-sensitive touch panels. The film features high suppleness and bending resistance that makes it useful for flexible, wearable devices.

Fig.2 External view of film

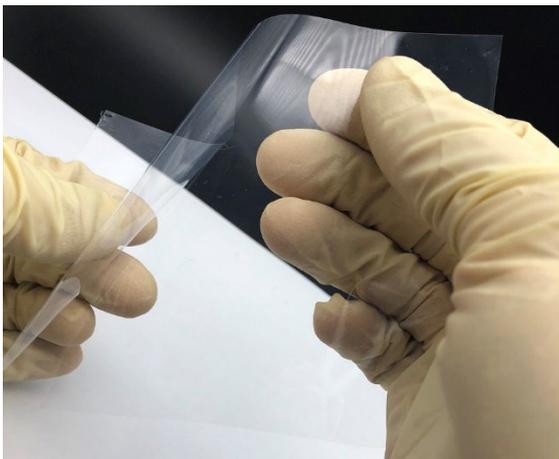


Fig.3 External view of film (high transparency)

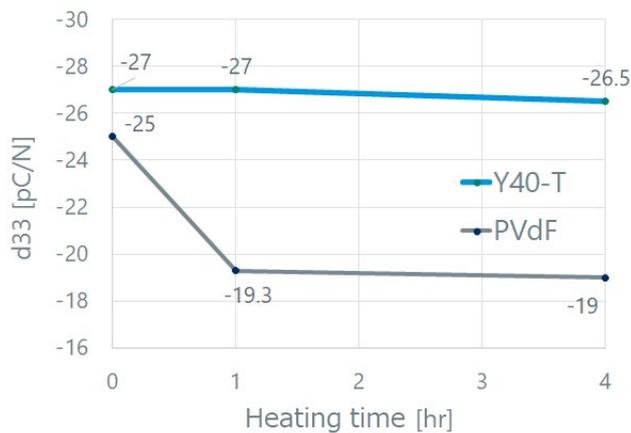
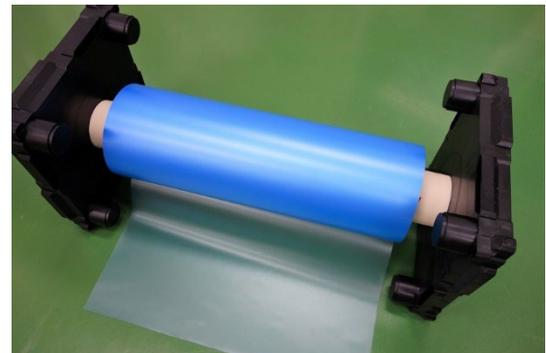


Features and grades

- High transparency and piezoelectricity
 - Greater piezoelectric heat resistance than that of stretched PVdF (see Fig.4).
 - Isotropy (differences in physical properties are small between vertical and horizontal in-planes [birefringence, $d_{31} \approx d_{32}$])
 - Reliability
 - High temperature and high humidity tests: No significant deterioration at 85°C/85RH% x 240 hr
 - Heat shock test: No significant deterioration at -40°C \Leftrightarrow 85°C x 200 cycles
 - Low heat shrinkage: 0.9% or less in 75°C x 1 hr test, especially 0.2% or less in the Y40-T
 - High-quality film with few fluctuations and defects due to Daikin's unique continuous processing technology
 - Roll specifications (width [mm]: 500, length [m]: 50-300)
- * Resin is also available.

Table.1 Physical characteristics / functions of piezoelectric film (development product)

Physical characteristics / functions			Transparent piezoelectric film (development product) Vdf/TFE copolymer			Stretched PVdF film
			High transparency	↔	High piezoelectricity	
			X20-T	X40-TP	Y40-T	
Film thickness (um)			20 (±2%)	40 (±2%)	40 (±2%)	40 (±6%)
Electrical properties	Piezoelectric strain constant	d33 (pC/N)	-6	-15	-27	-25
		d31 (pC/N)	5	9	14	18
		d32 (pC/N)	5	9	14	2
	Piezoelectric voltage constant	g33 (Vm/N)	0.08	0.19	0.34	0.22
		g31 (Vm/N)	0.06	0.11	0.18	0.16
		g32 (Vm/N)	0.06	0.11	0.18	0.02
	Piezoelectric constant in-plane error (%)		±3	±3	±3	±10
	Pyroelectric coefficient (uC/m ² ·K@25°C)		8	23	36	32
Dielectric constant @1kHz (-)		9	9	9	13	
Optical properties	Total light transmittance (%)		94	94	93	93
	Haze (%)		0.8	1.5	2.8	20
Thermal dimensional stability	TD thermal shrinkage, 75C/1h (%)		<0.9	<0.6	<0.2	0.1
	MD thermal shrinkage, 75C/1h (%)		<0.2	<0.1	<0.1	2
Mechanical properties	Young's modulus (GPa)		0.8	0.8	1.0	1.7

Fig.4 Electrical properties of transparent piezoelectric film (development product) (Aging of d33 at 90°C)

Fig.5 External view of roll


Expected industries and application

- Human Machine Interface (HMI) in information terminals/ PCs (flat keyboards such as dual displays and folding devices, proximity sensors, and ultrasonic sensors)
 - : Transparent and highly sensitive piezoelectric and pyroelectric films
- Automotive (e.g., navigation touch panels, seat sensors, and collision impact sensors)
 - : Film that excels in design
- Healthcare (sleep sensors for mattresses, pulse/heart rate sensors)
 - : Film with excellent flexibility and durability to repeated stress
- FA / industrial equipment (equipment abnormality [vibration] sensors)

Fig.6 Expected industries and application examples

All the data shown in this report are not guaranteed.

In addition, this development product is intended for general industry, and therefore its adequacy and safety as a raw material for medical purposes cannot be guaranteed.

For more information, visit our website.

DAIKIN INDUSTRIES, LTD.

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