おっ！と驚く、セラミックス。

Surprising Ceramics.

日本ガイシ NGK

EnerCera エナセラ®

December 16th 2021 Flex Japan

Ultra-compact and thin rechargeable battery that contributes to FHE

FHEに貢献する超小型･薄型2次電池

NGK INSULATORS,LTD.

EnerCera Marketing Team Group Manager

Ritsu Tanaka 田中 立

Todays　Outline

- About NGK
  - ・Corporate　Profile
- About EnerCera®
  - ・Outline of products
  - ・Application of　FHE devices
  - ・Deployment to maintenance-free IoT devices
- Closing

Todays　Outline

- **About NGK**
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Outline of NGK

Company Name	**NGK INSULATORS, LTD.**
Date of Establishment	**May 5, 1919**
Paid-in Capital	**69,849 Million Yen**
Representative Directors	Chairman **Taku Oshima**
	President **Shigeru Kobayashi**
	Executive Vice President **Hiroshi Kanie** **Chiaki Niwa**
Number of Employees (consolidated)	**19,695** ※Outside Japan employees **63%** As of March, 2021
Consolidated Subsidiaries	**45 companies** ※Outside Japan Subsidiaries **30** As of March, 2021

Contributing to society

1919

NGK was created to help Japanese society modernize by meeting the growing demand for electricity

A piece of the insulator that sparked the foundation of NGK Insulators. (1905)

The first president Kazuchika Okura stated,

“It is our duty to our country to produce insulators in Japan.”

▲Workers put the finishing touches on insulators in the early days.
◀The first tunnel kiln to be installed at our factory at company headquarters. (1920s)

©2021 NGK INSULATORS, LTD.

The Origin of NGK

1876 森村商事株式会社 MORIMURA BROS., INC. Porcelain Export

1904 Noritake China ware

1917 TOTO Sanitary ware

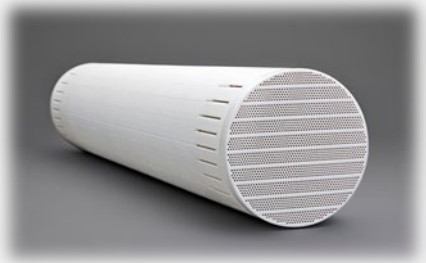
1919 NGK INSULATORS

1936 NGK SPARK PLUGS NTK TECHNICAL CERAMICS NGK SPARK PLUG CO., LTD. Spark plug

New Value to Be Provided by NGK

CO_2 separation membranes

Under harsh usage,
realizing high-precision separation
and capture of CO2



Zinc rechargeable batteries

As there is no risk of fire accidents,
they can be installed indoors and
safely realize emergency power supply
and renewable energy utilization

Future products

SOEC (Solid oxide electrolyzer cells)

We will use ion-conducting ceramics to create fuels and raw materials from CO_2 and water with high efficiency

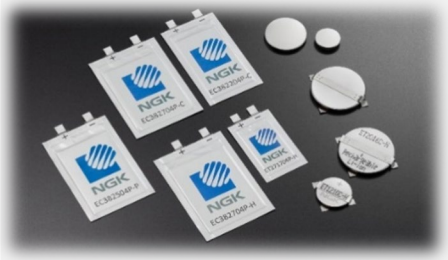
Honeycomb structural reactors for synfuel

We will utilize large-scale extrusion and separation membrane technologies to make fuel and raw-material synthesis more efficient

Carbon Neutrality

EnerCera ®

Realizing a maintenance-free IoT
More secure smart cards
Wearable devices closer to our life



Wafers

Contribution to 5G and next-generation telecommunications networks with high speed and high data capacity

Future products

Sensors for mobility

Our high-precision package technology will contribute to the realization of autonomous driving, such as the evolution of LiDAR

New bonded wafers (for sensing devices and next-generation telecommunications networks)

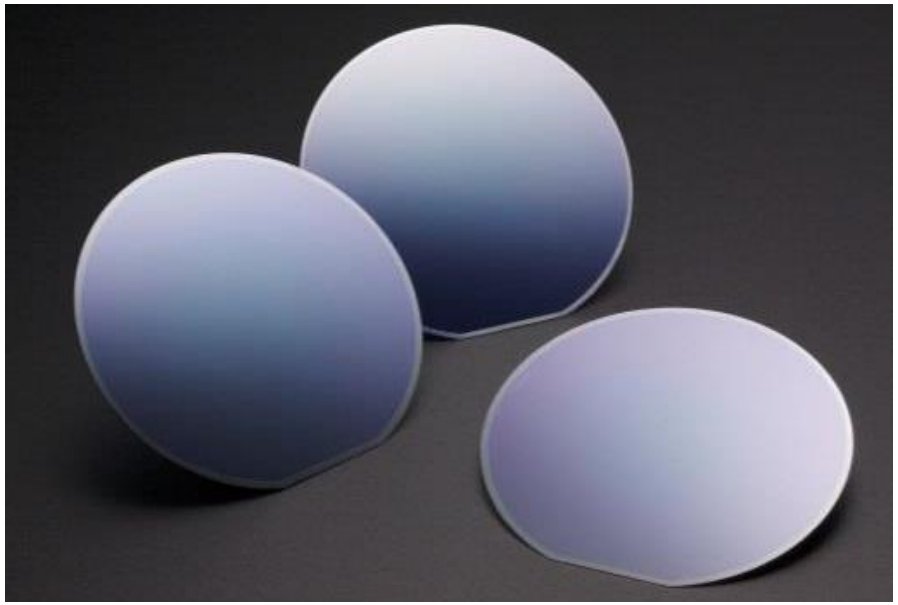
Contributing to autonomous driving sensors and ultra-high-speed communication by utilizing ultra-thin polishing and multi-materials bonding technologies

Digital Society

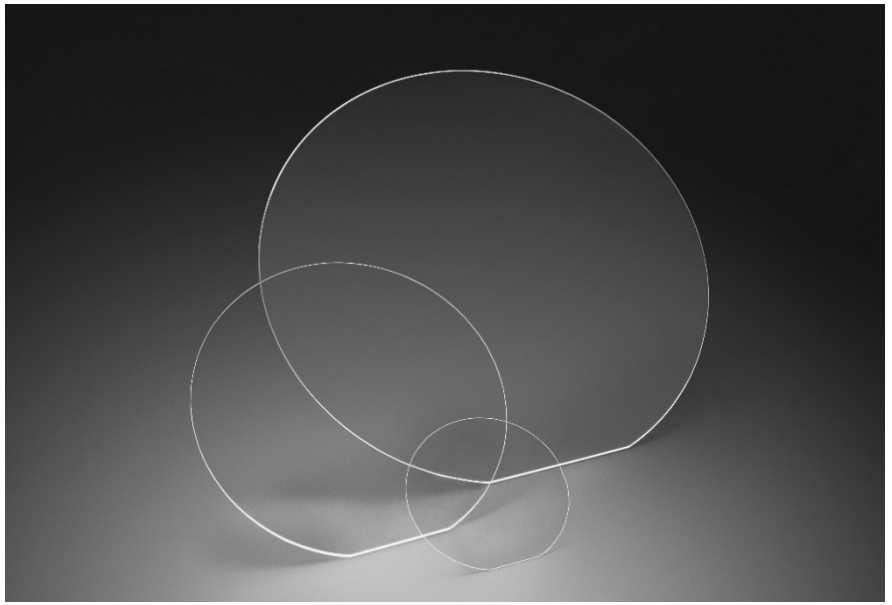
Ceramic Technologies
Materials・Processes・mass-production technology

Main Products/Electronics Business Group

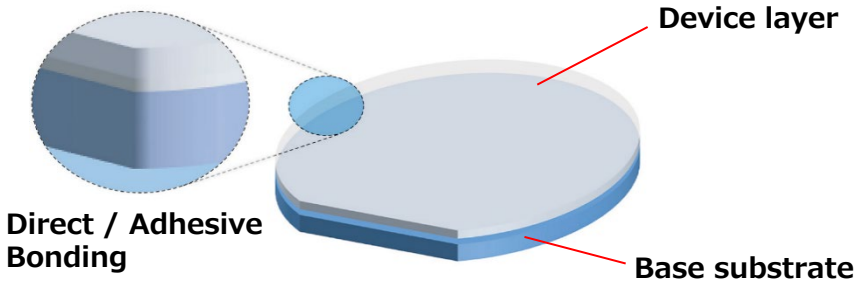
Advanced Device Components
For advancement of electronics

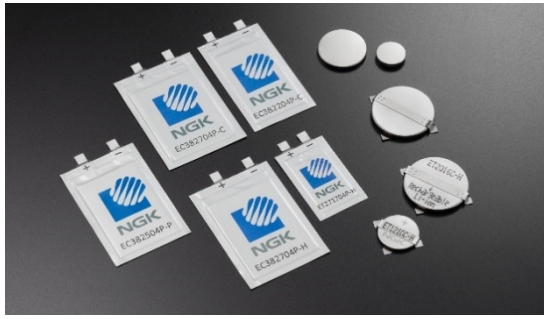


Bonded wafers for SAW filters



Gallium nitride (GaN) wafers





◀Chip-type ceramic rechargeable batteries **EnerCera** ® series

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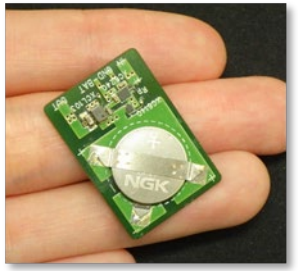
What is EnerCera Battery ?

EnerCera battery has the unique characteristics of both Lithium-ion rechargeable battery and capacitor

EnerCera battery series is a semi solid-state* rechargeable battery which incorporates NGK's proprietary crystal-oriented ceramic electrodes.

※A solid, multi-layered structure incorporating a crystal-oriented cathode active material sintered which infused with a small amount of liquid electrolyte

EnerCera Pouch



EnerCera Coin

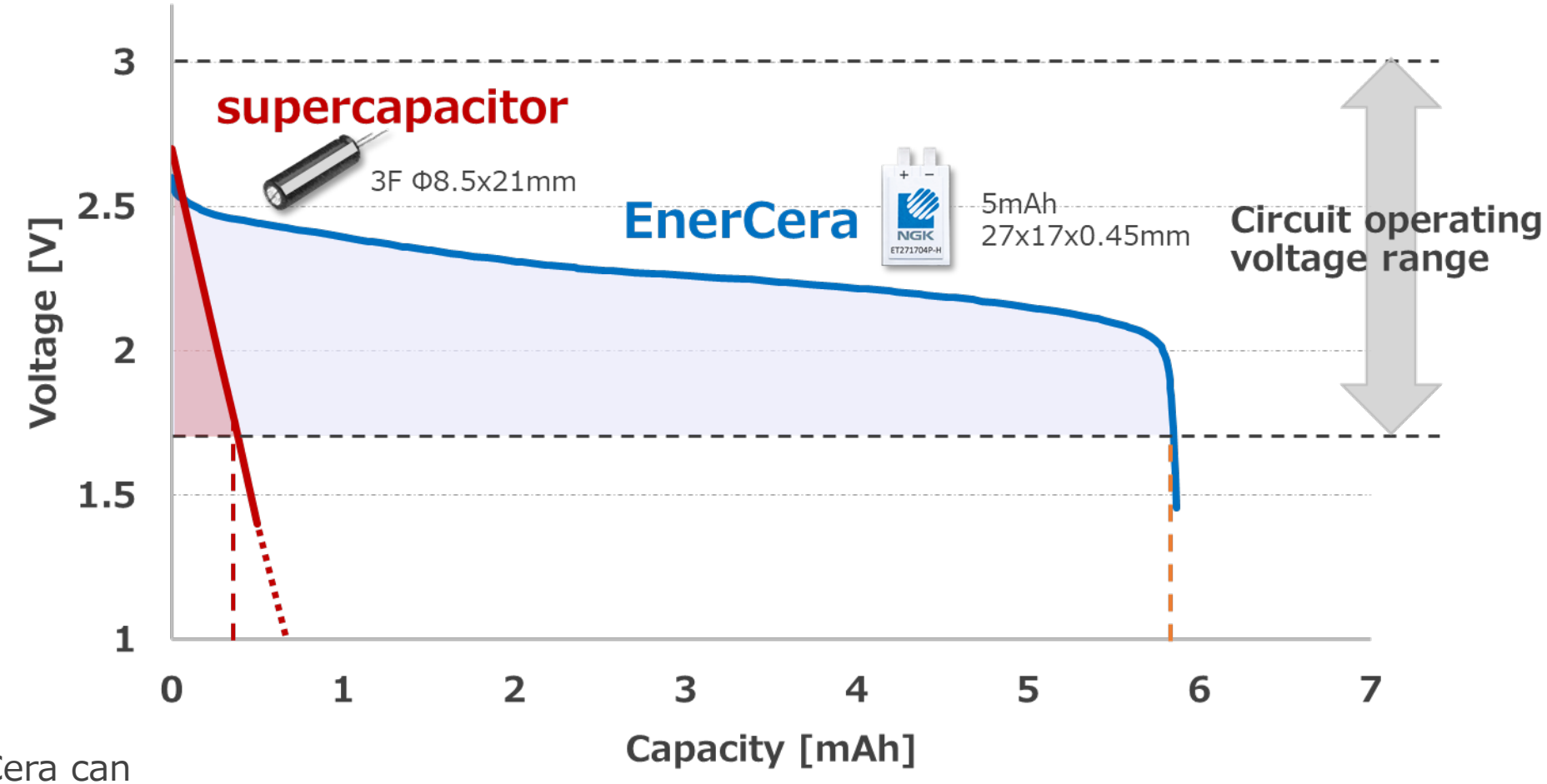
Application: Card type devices, RFID Tags
Wearable devices, ESL, etc.

Features: Ultra-thin (0.45㎜), Bending resistance,
High-speed charging

Application: Small sensor devices, industrial equipment
/in-vehicle products, backup power supplies, etc.

Features: High heat resistance (~ 105 ℃),
reflow solder mounting, constant voltage

Comparison with EnerCera and capacitor



EnerCera can

- ✓ output much higher energy at stable voltage between circuit operating voltage 1.8～3.0V than capacitor.
- ✓ output high current suitable for wireless communication of BLE etc. due to the low internal resistance compared to other small batteries(primary, rechargeable).

⇒ **EnerCera can output high current such as capacitor and is a new storage device that is able to discharge at stable voltage, not capacitor.**

※This material is for reference only and is not guaranteed by the Company.

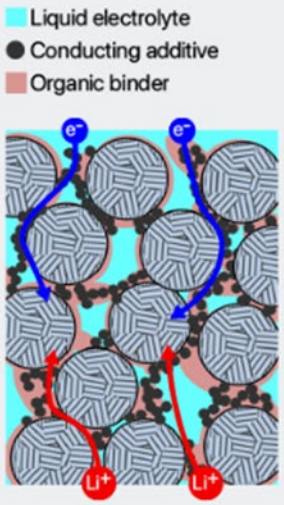
EnerCera's key technologies

Conventional Lithium-ion Batteries

Coated-Powder Electrode

Electrode active material is bound with conducting additives and organic binders.

At high temperatures, the organic binder reacts with the liquid electrolyte causing a reduction in binding strength.



Features

- Low energy density
- High electrical resistance
- Low thermal resistance

NGK EnerCera Coin

Proprietary Crystal-Oriented Ceramic Electrode

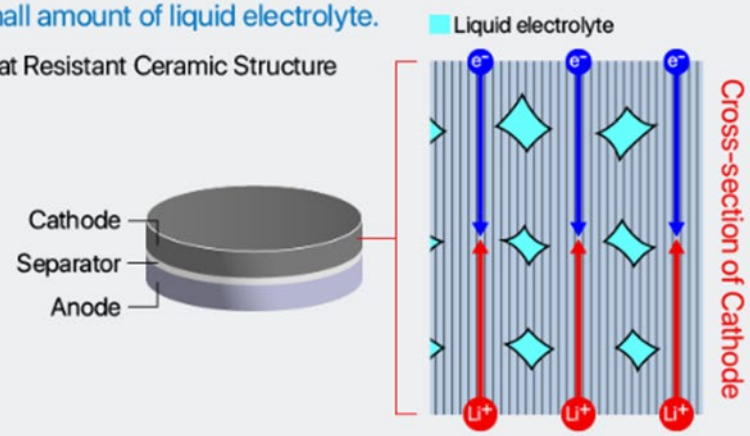
Cathode active material comprises crystal-oriented sintered ceramic.

- Lithium-ions and electrons travel rapidly through active material
- No organic binders or conducting additives

Proprietary Semi Solid-State Battery Technology

Multi-layered structures incorporates sintered ceramic infused with a small amount of liquid electrolyte.

- Heat Resistant Ceramic Structure



Features

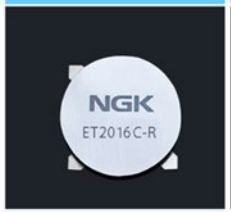
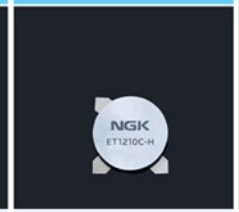
- High energy density
- Low electrical resistance
- High thermal resistance
- Long life expectancy

EnerCera Lineup

Model Number	EC382704P-T (New number under development)	EC382504P-P	EC382704P-C	EC382204P-C	EC302304P-C	EC382704P-H	ET271704P-H
Appearance							
Dimensions	38 x 27mm	38 x 25mm	38 x 27mm	38 x 22mm	30 x 23mm	38 x 27mm	27 x 17mm
Thickness	0.45mm						
Nominal Capacity (Charging Voltage)	27mAh (4.3V) 24mAh (4.2V)	20mAh (4.2V)	27mAh (4.3V) 24mAh (4.2V)	20mAh (4.3V) 18mAh (4.2V)	15mAh (4.3V) 14mAh (4.2V)	20mAh (4.2V)	5mAh (2.7V)
Nominal Voltage	3.8V						2.3V
Charging Condition	Constant current (CC) - Constant Voltage (CV) charging						CV charging
(Ref.) Peak Discharge Current*1	560mA	500mA	260mA	200mA	130mA	130mA	100mA
Bendability	Conforming to ISO 14443-1 standard No deterioration after bending and torsion tests						
Operation Temp.	Discharge : -20℃ ~ 45℃ (Charge : 0℃~45℃)					Discharge : 20℃~60℃ (Charge : 0℃ ~ 60℃)	-40 ~ 70℃
Heatproof Temp. (in process)	80℃					135℃	
Features	High Power		High capacity			High heat resistance	Fast charging*2

*1 Voltage drop is less than 0.5V with continuous discharge for 0.1 sec. (at 25℃)
*2 Can be charged from 0% to 80% capacity in 14min.

IEC62133 certified
Contents may be changed without notice.

Model Number	ET2016C-R	ET1210C-H	ET2016C-H
Appearance			
Size	Φ20 x 1.6mm	Φ12.5 x 1.0mm	Φ20 x 1.6mm
Nominal Capacity (2.7V charge)	25mAh	4mAh	20mAh
Nominal Voltage	2.3V		
Charging Condition	Constant Voltage (CV) charging (No current control required)		
(Ref.) Peak Discharge Current*1	60mA	20mA	45mA
Operation Temp.	-40℃ ~ 60℃	-20℃*2 ~ 105℃	125°C type Under development
Implementation specifications	Reflow soldering applicable*3		

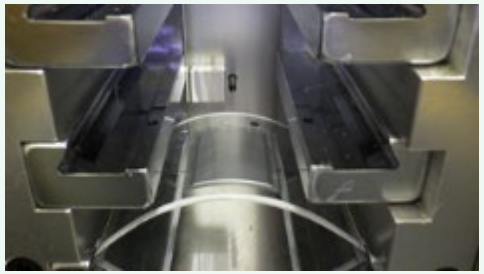
*1 Voltage drop is less than 0.5V with continuous discharge for 0.1 sec. (at 25℃)
*2 -40°C to 105°C for RTC backup applications.
*3 Please check with us for the conditions.

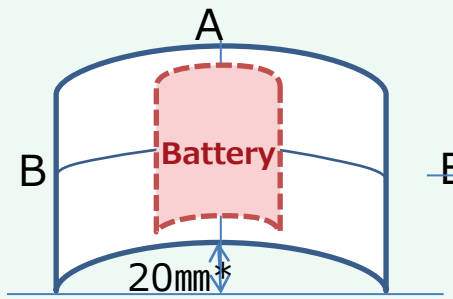
IEC62133 certified
Contents may be changed without notice.

We have a wide lineup of EnerCera pouches and coins such as high-power type, high-capacity type and heat-resistant type.

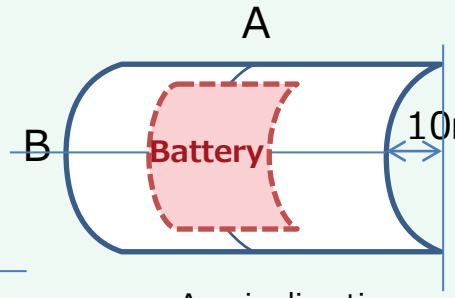
Bending Resistance of EnerCera Pouch

Compliant with ISO14443-1 “Physical Characteristics of IC cards"





B-axis direction
500 times



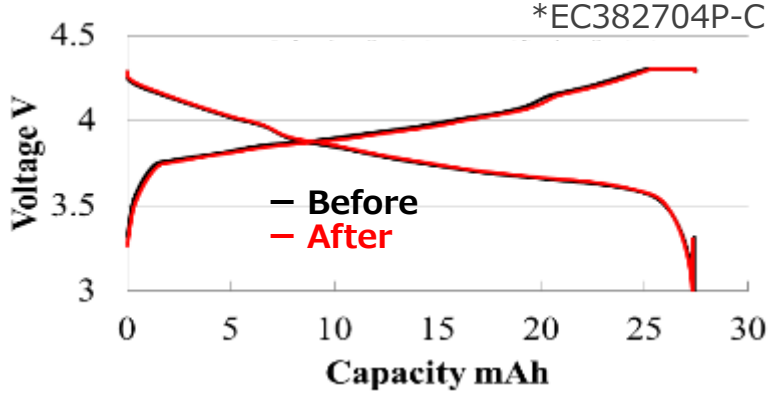
A-axis direction
500 times

＊Radius of curvature 40mm

Total 1000 times

Charge/Discharge Characteristics

*EC382704P-C



Appearance (wrinkles, etc.)	:	No change
Charge/Discharge characteristics	:	No change
Battery resistance	:	No change
Cycle characteristics	:	No change

No change in characteristics after bending test (1000 + 5000 times)

※This data in this material is for reference only and NGK makes no warranty.

EnerCera Pouch mounting support

The following two methods are recommended for joining the tabs of the EnerCera pouch.

■Solder for Al terminal

	Solder alloy	Flux	Method	Temp.	Result
Ref.	General	No	General	330℃※1 (Pb) 370℃※1 (Pb free)	NG
①	For Al use※2	Yes※3	General	400℃	OK
②	For Al use※2	No	Ultrasonic soldering※4	–	OK

※1) Quoted from Marutsuelec Co., Ltd. HP
※2) lead-free solder alloy (Sn-Ag-Cu system) with electrolytic corrosion resistance
※3) ALUSAC-35 to be used with Flux (Nihon superior No.1261))
※4) The cavitation effects surface cleaning as flux usage

⇒NGK recommends ① or ②.

＊Please note that it cannot be mounted with general solder.

■ICF bonding

Company		Showa Denko Materials
ICF type		IC-01A
Thickness		25μm
Condition	Temp.	144℃
	Pressure	2.5MPa
	Time	10sec

⇒144℃×2.5MPa×10sec

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The future that EnerCera can realize

Feature of EnerCera

High heat resistance
& High durability

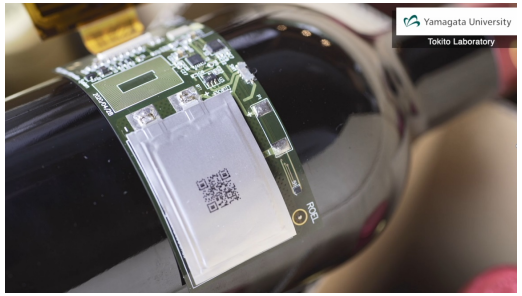
High capacity

High power

It is possible to add new functions to small and thin devices.
Free design is possible, and the range of applications is infinite.

Smart card

Distributed power supply
for automobiles



Position tracker
Logistics tag

Maintenance-free
IoT devices

Application development of EnerCera ® series

The world of applications enabled by the EnerCera series

Life


Air quality monitoring


Watching

Wearable


Sports

Healthcare


Wireless Earphone


Watch


ID

Smart card


Smart home

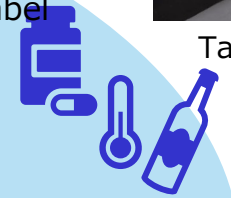
Logistics and Retail

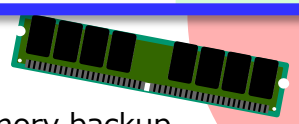

Picking system

Electronic shelf label


Tracking


Tags with sensors


Quality


Memory backup


Worker monitor


Sensor module


Infrastructure monitor


Smart agri

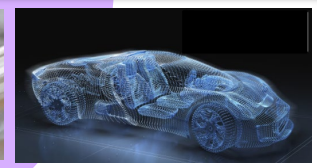

RTC、Encoder backup


Smart factory


Tire sensor


Car Sharing


Smart key


Interior･HMI


eCall、ECU Backup


Sensors for autonomous driving

Industry

Automobile

NFC charging smart card board

Cooperation: Fujikura Co., Ltd.
Torex Semiconductor Co., Ltd.

Non-contact and instant wireless charging Next-generation smart cards

A card board that supports short-range wireless communication standard "NFC" charging.

When a board incorporating **EnerCera** is used for an IC card, charging is possible instantly while payment is made.

It greatly improves the convenience of next-generation smart cards.

Storage of electricity

EnerCera® Pouch

Fast charging type ET271704P-H
27mm x 17mm x 0.45mm

Switch

Charging circuit
(power supply controlled rectifier circuit)

NFC powered coil

NFC powered LED
(flashing while receiving)

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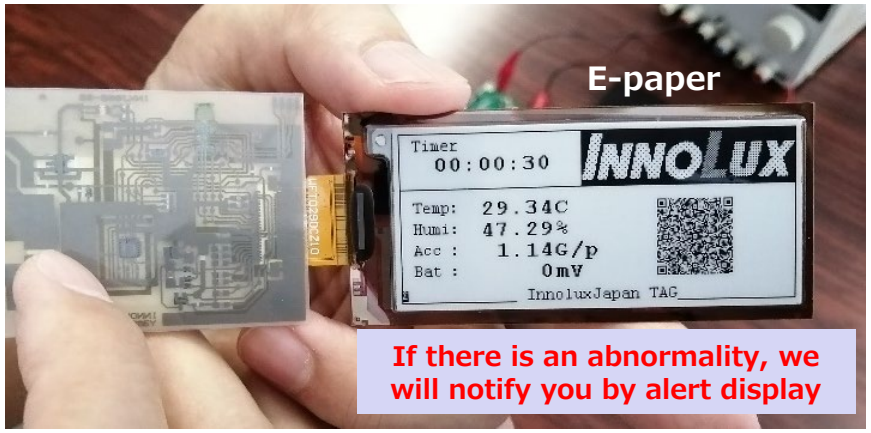
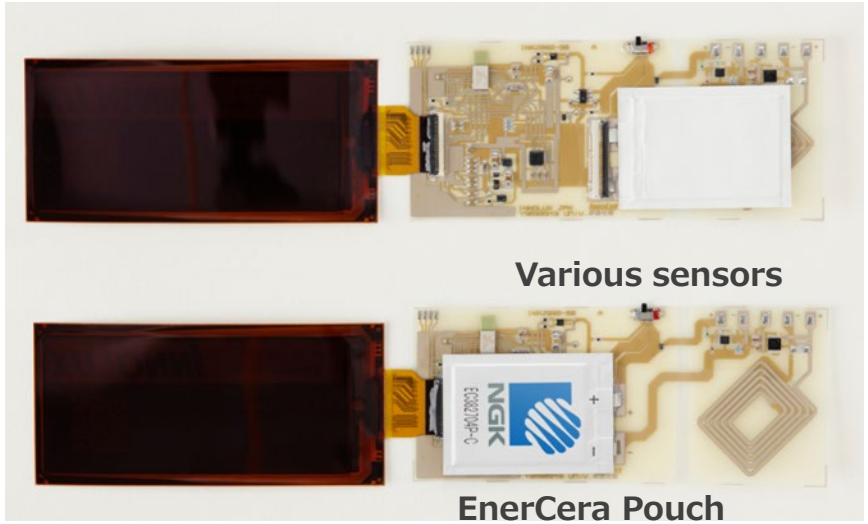
Flexible Sensor Tag

Cooperation: Innolux Japan Co.,Ltd.
Tokito Laboratory, Yamagata University

1.The thin and flexible EnerCera battery can be attached to curved surfaces.
2. Durable and reliable EnerCera battery can be used even in harsh environments
3.Maintenance-free is possible in combination with wireless power supply and energy harvesting technology





HACCP, towards GDP
Real-time monitoring of transported goods

Product	Flexible logistics tags
Size	40㎜×80㎜
Charging	Near field wireless charging
Communication	BLE
Sensing function	Temperature, humidity and impact sensing
Use Case	‣ Cargo management during transportation, factories and warehouses ‣ cold chain
Adopted part number	EC382704P-C EC382704P-H

Flexible Sensor Tag for curved surfaces

Cooperation: Innolux Japan Co.,Ltd.
Tokito Laboratory, Yamagata University

For tracking and quality control
Ultra-thin and smart electronic tags

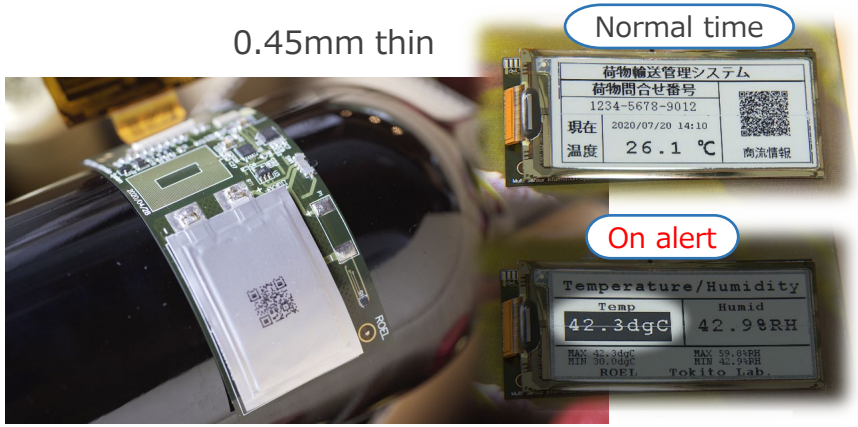
The ultra-thin, bend-resistant **EnerCera Pouch** provides a flexible center tag for curved surfaces.

"Maintenance-free" by eliminating the need for battery replacement.

For tracking, temperature and humidity monitoring, impact detection and wireless data communication.

Storage of electricity **EnerCera® Pouch**

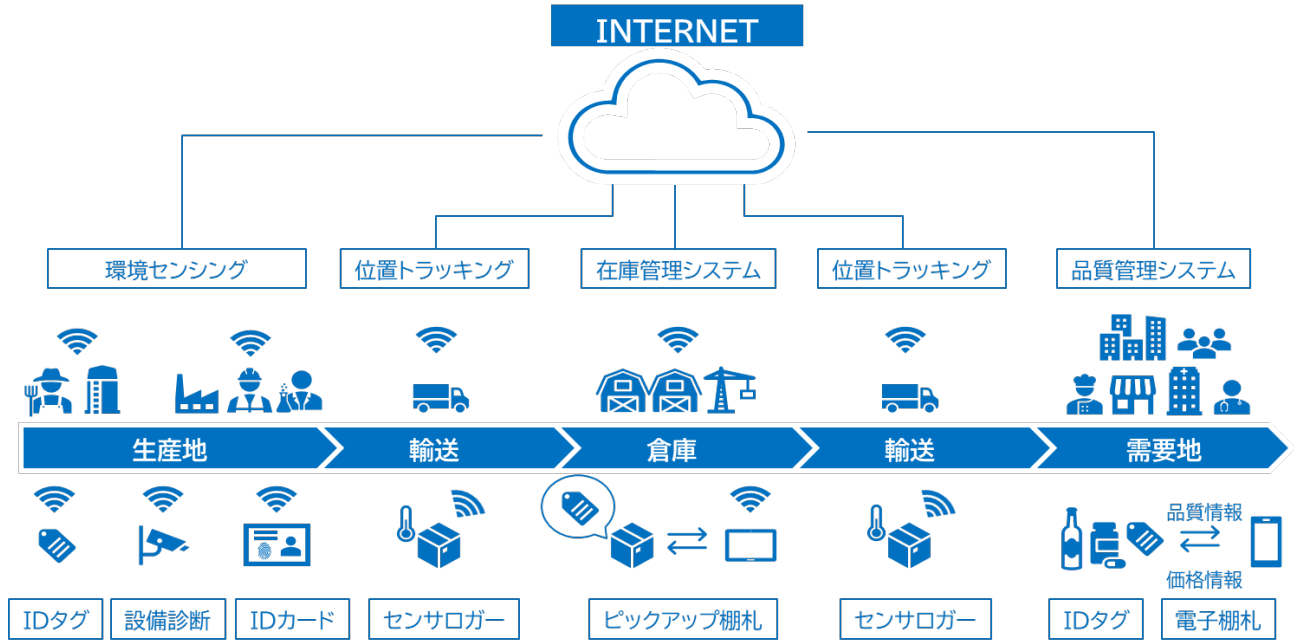
0.45mm thin



Normal time

On alert

A warning is displayed when the temperature sensor senses a high temperature



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Flexible Sensor Tag for curved surfaces

Cooperation: Innolux Japan Co.,Ltd.
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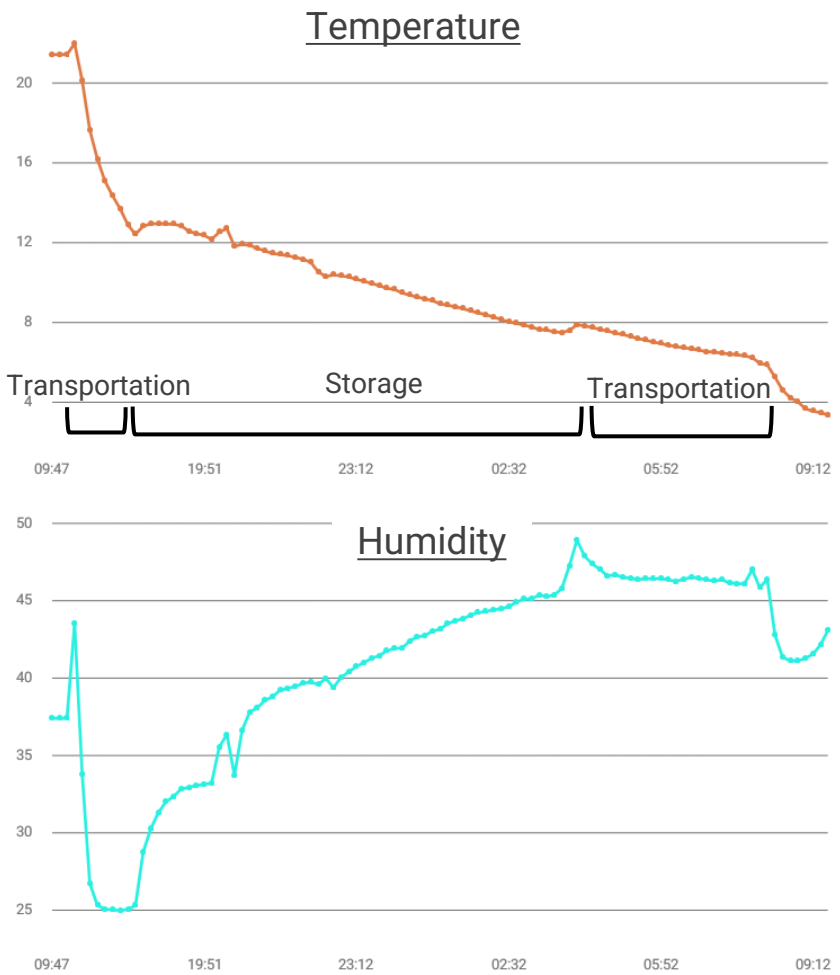
Actual measurement data during refrigerated transportation



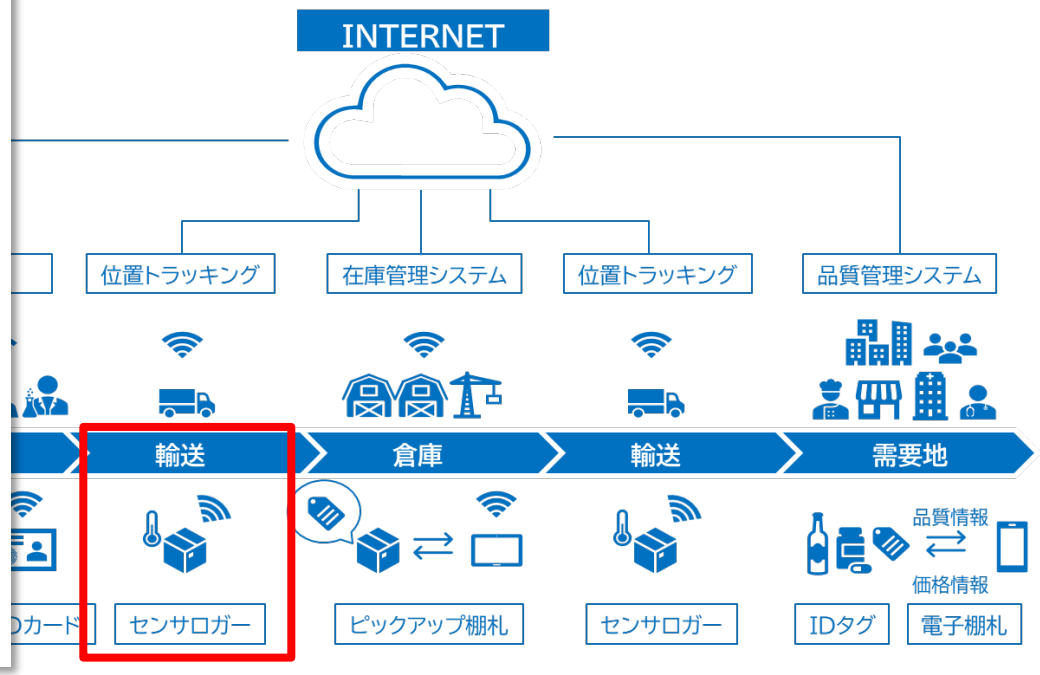
Storag

and quality control
nd smart electronic tags

end-resistant **EnerCera Pouch** provides a flexible
rved surfaces.

ee" by eliminating the need for battery replacement.

perature and humidity monitoring, impact detection
a communication.



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Medical patches

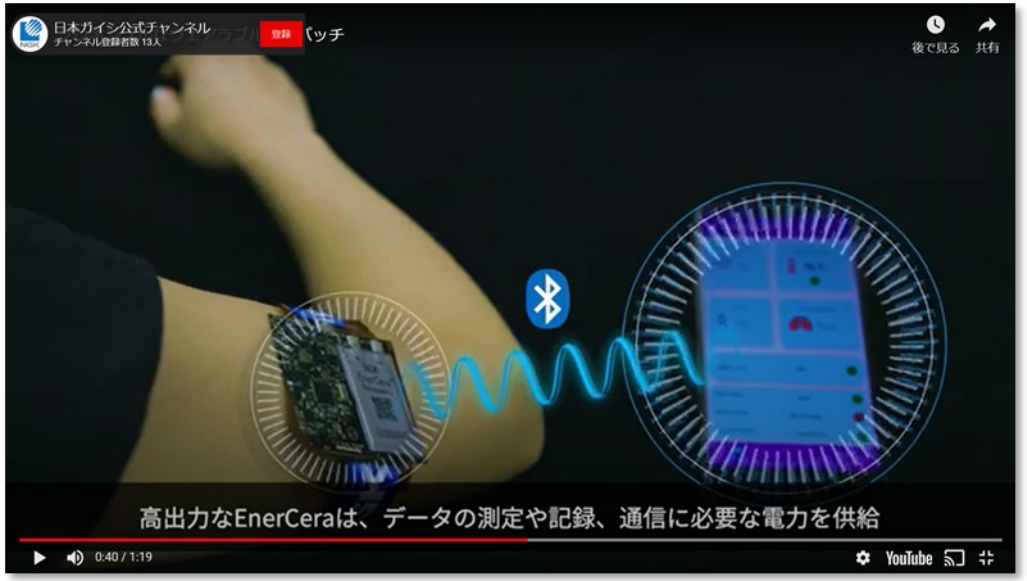
Cooperation: Renesas Electronics Co., Ltd.

1. Ultra-compact and thin with a thickness of only 0.45 mm, and has bending resistance, making it ideal as a power source for wearable medical patches.
2. EnerCera Pouch battery has high output and can drive BLE etc.
3. Devices are reusable because it uses battery that can be recharged repeatedly

Rechargeable battery

EnerCera®

https://www.renesas.com/jp/ja/application/healthcare/medical-patch



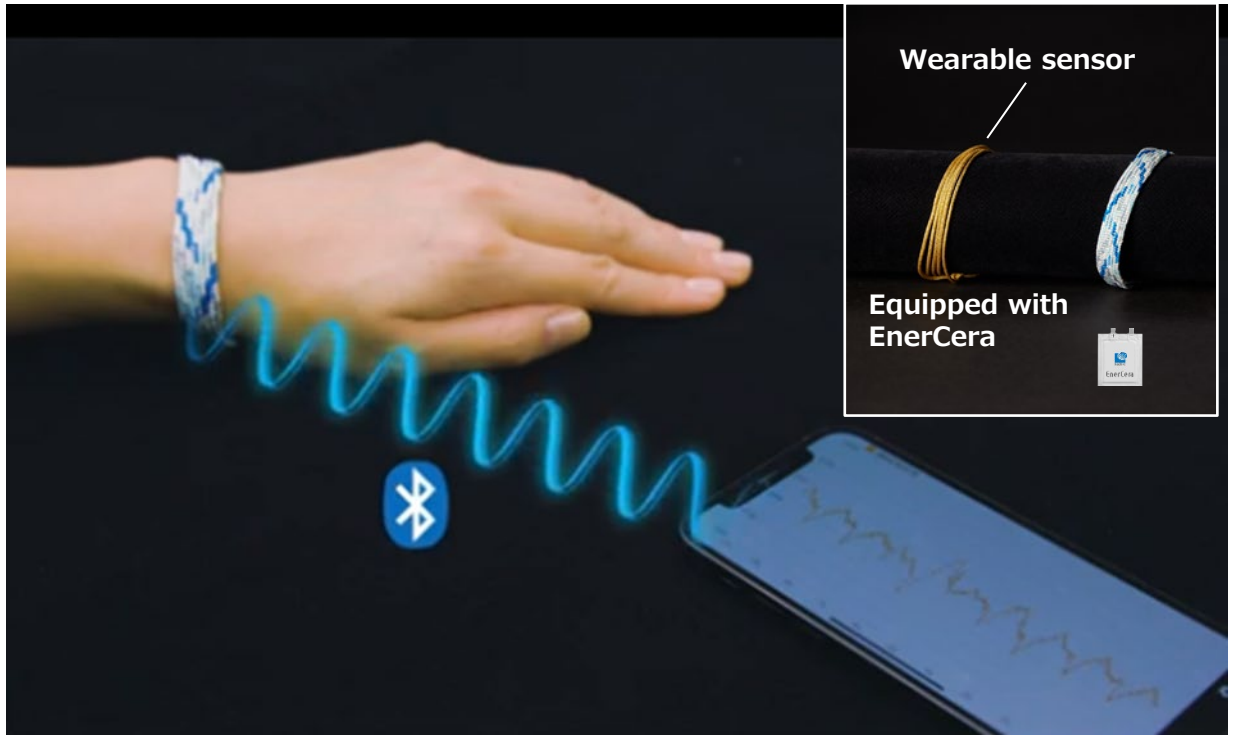
・Highly accurate monitoring of biological data such as heart rate, respiration rate, and oxygen saturation (SpO2)
・Low-profile, bendable, low-resistance EnerCera Pouch for low power consumption and a good fit medical patch
・Renesas RX MCU enables secure BLE communication of sensing data

※This material is for reference only and is not guaranteed by the Company.

Piezoelectric braid type wearable sensor

Cooperation: Kansai Univ./ TACHIBANA ELECTRONIC SOLUTIONS /SHINSEI DENSHI/TEIJIN FRONTIER/Renesas Electronics

1. Using ultra-compact EnerCera Coin battery, sensor module can be miniaturized.
2. Although it is small and thin, EnerCera battery has a high capacity and high power that supports sensing and data communication.
3. Highly durable and highly reliable semi-solid-state battery, ideal for wearable applications.



Product	Piezoelectric braid sensor
Charging	USB
Communication	BLE
Sensing function	Biosensor
Use Case	Vital monitor, Sleep monitor, Pet monitor
Product number	EC302304P-C

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  - **・Deployment to maintenance-free IoT devices**
- Closing

Maintenance-free IoT device with EnerCera Batteries

Charging EnerCera constantly and discharge at high power when needed
➡ Practical maintenance-free IoT device becomes feasible

Maintenance-free IoT device

IoT Society

Infrastructure
Logistics/Retail
Automobile
Healthcare/Medical
Construction
Security/monitoring
Livestock Manufacture
Smart home
Data security

Power Generator or Power Supply

・Wireless Power Supply
・Energy Harvesting
(PV, Vibration, etc.)

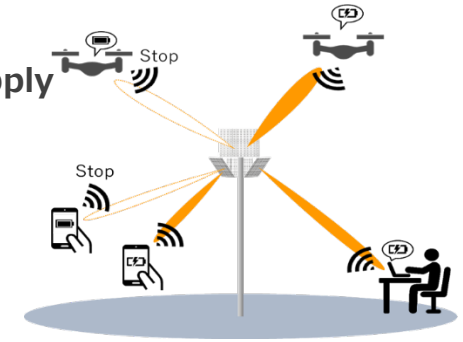

Image:Wireless power supply in the city
source : SoftBank News 2020.9.10

Depending on the environmental conditions

Inoperable or unstable !

IoT device

Various sensors, CPU, memory, communication modules, etc.

Maintenance-free IoT device with EnerCera Batteries

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Maintenance-free IoT device

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Power Generator or Power Supply

- Wireless Power Supply
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Constant charging with μW level power

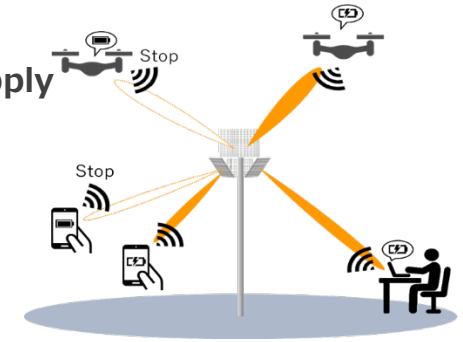


Image:Wireless power supply in the city
source : SoftBank News 2020.9.10

Energy Strage device EnerCera Battery

EnerCera®

Superior Battery feature	Capacitor like feature
・Small, High Capacity	・High Power
・Constant voltage output (keep the voltage for IC)	・Constant voltage charging
・Low self-discharge	・Long life
	・Reflowable

Discharging Intermittently with large current, several 10mW level

IoT device

Various sensors, CPU, memory, communication modules, etc.

Partnerships in maintenance-free IoT devices

Power generation / power supply		Items	Partner
Energy harvesting	Solar cell	Position tracker	Renesas electronics/SEMTECH
		Smart agricultural sensor	Renesas electronics/SEMTECH
		Various IoT devices	RICOH
Wireless power transfer	920MHz	Logistics sensor tag	Panasonic
		Smart remote control	SMK
	2.4GHz	Logistics IoT devices	Marubun/JAE
	5.7GHz	Failure prediction device	Toshiba/Tokai electronics
EnerCera evaluation board		Evaluation board	Torex semiconductor
		power storage unit	Rohm
		maintenance-free power supplies	Fujikura/e-peas

**DSSC : Dye-Sensitized Solar Cell

Examples of cooperative partners for maintenance-free IoT devices

Always powering EnerCera, outputting the power needed from EnerCera

➡ To realize practical maintenance-free IoT devices!!

Maintenance-free IoT device

IoT Society

Infrastructure
Logistics/Retail
Automobile
Healthcare/Medical
Construction
Security/monitoring
Livestock
Manufacture
Smart home
Data security

Power Generation and Power Supply Dept.

Environmental power generation	Photoelectric: Ricoh, Exeger/SB Energy
	Mechanical: Kanazawa University, Ricoh, Canon
	Thermoelectric: E Thermogentech
Wireless power supply	Panasonic, Sonic Energy, Toshiba, Ossia/Marubun, Powercast

Constant charging with μW level micro power

Energy Storage Device Dept.

Power SUPPLY IC	TOREX, Ricoh Electronic Devices, Ricoh, ROHM

Intermittent discharge at high power levels of several tens of mW

IoT Function Dept.

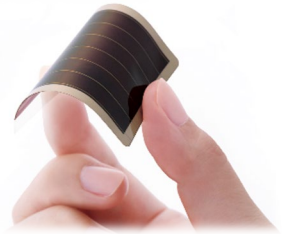
Device IC	Renesas Electronics, Ricoh, ROHM/Lapis Semiconductor, Seiko Epson, Ablic

An example of collaboration ／RICOH

Flexible power supply device that combines solar cells and EnerCera

A thin, light and bendable solar cell that can generate electricity efficiently indoors and in the shade.

OPV



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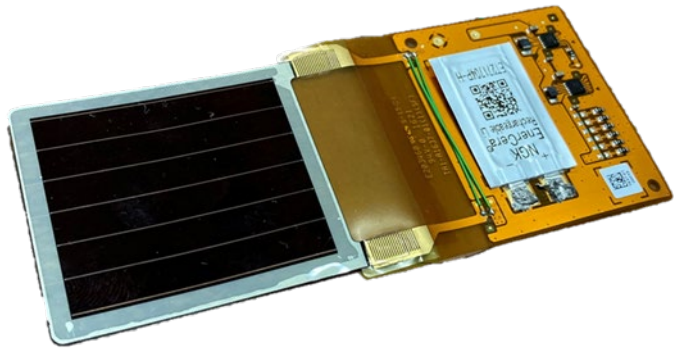
Compact, thin and high-capacity power storage device.

EnerCera

Flexible power supply device

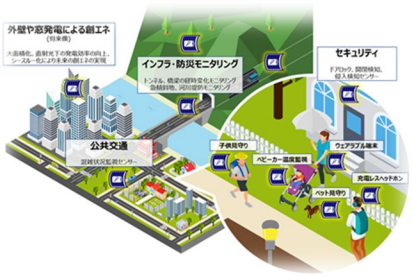


Application

Industry

Agriculture

Life



source : RICOH

Todays　Outline

- About NGK
  - ・Corporate　Profile
- About EnerCera®
  - ・Outline of products
  - ・Application of　FHE devices
  - ・Deployment to maintenance-free IoT devices
- Closing

Future efforts

Contribute to the promotion of carbon neutral and digital society

Carbon Neutrality

- **Waste reduction**

Aiming for the phasing out of primary batteries

- Circular Economy Action Plan (EU)
- New batteries Regulations (EU)

- **Utilization of energy harvesting technology**

Combination with solar cells, vibration power generation, etc.

Digital Society

- **Popularization of IoT**
- **Advances of communication technology**

5G, 6G communication

- **Higher security**

Personal information protection

Realization of a truly maintenance-free IoT device

Sumary

- ✓ EnerCera is a new power storage device that combines the features of batteries and capacitors.
- ✓ The EnerCera pouch is thin and easy to bend, making it ideal for flexible devices such as smart cards, logistics tags, and medical wearables.
- ✓ In combination with Energy Harvesting and WPT, IoT devices can be made maintenance-free and contribute to the reduction of primary battery waste.

Please feel free to contact us for demonstrations using EnerCera or inquiries about EnerCera.

Thank you

Contact

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enercera-sales@ngk.co.jp