

# Hybrid Energy harvesting material and device

Hybrid Energy Harvesting materials and devices



**Patent title** Piezoelectric energy harvester arranged through self-coupling and having wide operating frequency range

**Inventor** Korea Institute of Science and Technology  
/ Song Hyeon-cheol, Kang Jong-yoon, Kim Sang-tae

**Patent application No.** KR 10-2019-0003371 (2019.01.10)/  
KR 10-2141074 (2020.07.29)

**Authority status** Registered

## Technicality

### 🔍 Technology overview

The technology relates to an energy harvester which enables self-generation through mechanical energy, such as vibration and a magnetic field, distributed at the surroundings without connection of a battery or a power line. Piezoelectric beams are coupled by a magnetic force or by using a mass that can move the piezoelectric beams. Thus, improved energy can be output, and a wide operating frequency bandwidth can be provided.

### 🔍 Development background and problem to be solved

- In the case of a piezoelectric energy harvester using vibration, when a resonant frequency deviates from a fixed natural frequency of a device, generated displacement is reduced, and a piezoelectric output is greatly reduced.
- Therefore, there is a need for a technology for applying a piezoelectric energy harvester to an environment, such as an engine of a car or an airplane, in which the frequency range of a vibration source is wide or a vibration frequency constantly changes.

### 🔍 Excellence and discrimination of technology

#### ▶ Excellence of technology

- An energy harvester can autonomously move so that an external vibration frequency matches a unique frequency of a device without a separate electric device.
- The energy harvester is applicable to a wide frequency range by expanding a resonant frequency band.
- A stable output can be maintained for  $10^9$  cycles.
- A maximum output of 27.04 mW of the harvester is achieved on the basis of an improved energy output.

#### ▶ Discrimination of technology

- By moving the movable mass to the position of the piezoelectric beam where resonance occurs, the displacement of the piezoelectric beam can be maximized to continuously generate high output voltage.
- Piezoelectric beams having different unique frequencies are coupled by a magnetic force. Thus, when a piezoelectric beam operates at one frequency, neighboring piezoelectric beams work together to have a wide resonant frequency range.
- It is possible to produce electrical energy from a magnetic field generated around a power line as well as the surrounding vibration by enabling mutual coupling by a magnetic force of a magnetic mass.

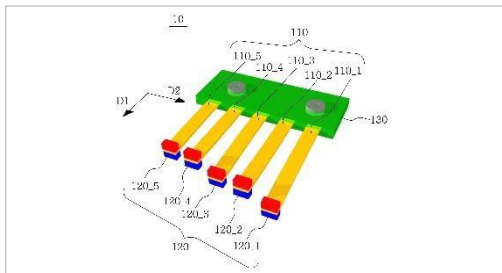
# Hybrid energy harvesting material and device

Hybrid Energy Harvesting materials and devices

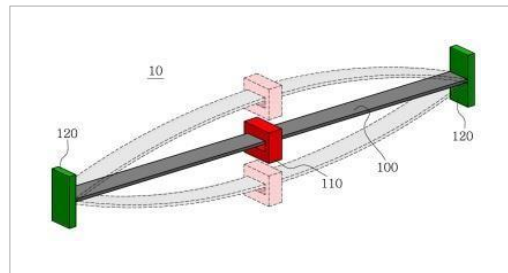
## Implementation method

According to the present invention,

- included therein are piezoelectric beams, a fixed member, and a mass connected to the piezoelectric beams.
- Several piezoelectric beams having different resonant frequencies are magnetically coupled so that when one piezoelectric beam operates, the other piezoelectric beams operate together.
- Alternatively, a mass connected to the piezoelectric beams moves to a position of the resonant piezoelectric beams to increase the generated displacement of the piezoelectric beams.



Picture 1 Energy harvester arranged through magnetic coupling



Picture 2 Self-resonant regulating piezoelectric energy harvester

## Degree of technology completion (TRL)

Degree of technology completion: TRL5 (implementation environment application experiment stage)

TRL1	TRL2	TRL3	TRL4	TRL5	TRL6	TRL7	TRL8	TRL9
Technical principle presentation	Technology concept setting	Technology concept verification	Lab scale prototype development	Implementation environment application experiment	Full scale prototype development	Quasi-commercial product development	Commercial product development	Commercial product implementation

## Utilization

### Utilization field and applied product

#### Utilization field

- Sensor power technology
- Power generation technology



Picture 1 Sensor power technology

#### Applied product

- Sensor main or auxiliary power source
- Generation element utilizing vehicle vibration on roads and parking lots



Picture 2 Generation element utilizing vehicle vibration

# Hybrid energy harvesting material and device

Hybrid Energy Harvesting materials and devices

## Technology trend

- After the discovery of the piezoelectric effect, device and process technology development is actively in progress. Recently, new materials such as micro synthetic fibers have been developed, and the research is invigorating.
- A nano piezoelectric material technology using ZnO or the like, a flexible composite piezoelectric material technology (nano + polymer), and a flexible piezoelectric transfer process technology of achieving a piezoelectric thin film material on a flexible substrate through a transfer process are being actively developed.
- In Europe, a consortium called vibration energy scavenging (VIBES) is being actively studied in the UK, Germany, France, Italy, and the like, and an MEMS process research for miniaturization to be applied to sensor networks is in progress in the US, China, and the like.
- In Korea, Ceracomp newly developed the Solid State Crystal Growth scheme and produced PMN-PT single crystals, which are on the market.

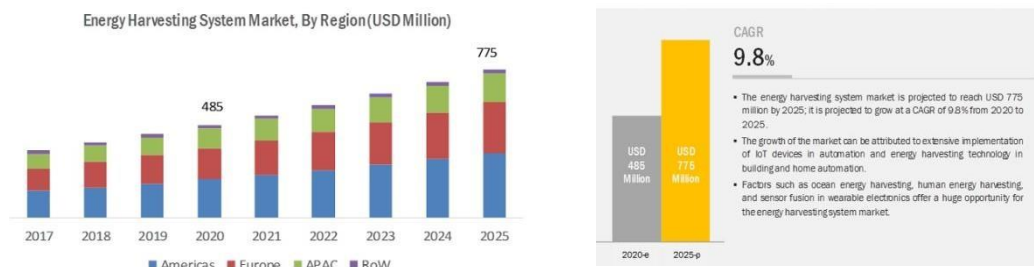
## Family patent status

Application nation	Application No. (Application date) / Registration No.	Title of the invention
KOR	KR 10-2019-0003371 (2019.01.10) / KR 10-2141074 (2020.07.29)	Piezoelectric energy harvester arranged through magnetic coupling and having wide operating frequency range
KOR	KR 10-2018-0101978 (2018.08.29) / KR 10-2125405 (2020.06.16)	Self-resonant regulating piezoelectric energy harvester having wide operating frequency range
US	US 16-296218 (2019.03.08) / US 2020/0076331 (2020.03.05)	SELF-RESONANCE TUNING PIEZOELECTRIC ENERGY HARVESTER WITH BROADBAND OPERATION FREQUENCY

## Market prospect

### Target market size and prospect

The global energy harvesting market size is expected to grow from USD 485 million in 2020 to USD 775 million in 2025, growing at an annual rate of 9.8%. The supply of a harvesting technology, reduction of carbon emissions, and the increased application of an IoT technology in buildings and industries are the growth factors of the energy harvest market. If an energy harvesting technology is commercialized in the future, the technology is expected to be actively distributed mainly in wireless network devices and low-power devices.



Graph Energy harvesting global market size

<Data: markets and markets\_2019>

## Technology transfer query

**DH** 두호특허법인 / (주)두호기술경영  
DooHo IP Law Firm / DooHo Tech. & Mgt. Inc.

**Patent attorney** Kyuhyeong LIM

**Contact** 070-4333-8021

**Email** khlim@dohopat.co.kr

## Technology transfer process

