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THE THERMAL RESONATOR IN OUR LIFE

Scientists from the Massachusetts Institute of Technology have developed a thermal resonator that generates electricity due to day-to-day fluctuations in air temperature. The prototype system is already working on the roof of one of the buildings of the Massachusetts Institute of Technology. It is designed to power sensors and small devices, and receives energy literally "out of nothing". The findings are being reported in the journal *Nature Communications*, in a paper by graduate student Anton Cottrill and professor Michael Strano. This is an advanced thermoelectric generator that operates on the principle of converting the difference in temperature into electricity. This principle is not new and is used in Peltier elements.

Compared to pyroelectrics — the most popular way to generate electricity by changing temperature — the thermal resonator showed a three-fold advantage in productivity. (Pyroelectrics - crystalline dielectrics with spontaneous (spontaneous) polarization, namely polarization in the absence of external influences.

Usually, spontaneous polarization of pyroelectrics is not noticeable, since the electric field created by it is compensated by the field of free electric charges, which “leak” onto the surface of pyroelectrics from its volume and from the surrounding air. With a change in temperature, the magnitude of the spontaneous polarization changes, which causes the appearance of an electric field, which can be observed until the free charges have time to compensate for it.)

“We basically invented this concept out of whole cloth,” Strano says. “We’ve built the first thermal resonator. It’s something that can sit on a desk and generate energy out of what seems like nothing. We are surrounded by temperature fluctuations of all different frequencies all of the time. These are an untapped source of energy.”

“They want orthogonal energy sources,” Cottrill says — that is, ones that are entirely independent of each other, such as fossil fuel generators, solar panels, and this new thermal-cycle power device. Thus, "if one part fails," for example if solar panels are left in darkness by a sandstorm, "you'll have this additional mechanism to give power, even if it's just enough to send out an emergency message." The advantage of the thermal resonator is that it does not need direct sunlight; it generates energy from ambient temperature changes, even in the shade.

That means it is unaffected by short-term changes in cloud cover, wind conditions, or other environmental conditions, and can be located anywhere that's convenient — even underneath a solar panel. The MIT researchers have been using an early prototype to power the weather monitoring system seen in the photo. The thermal resonator is in the black box located behind the white weather sensors. The black case to the left contains test equipment to monitor the performance of the prototype.

The developers conducted initial tests using 24-hour fluctuations in ambient temperature. However, they believe that the device can also generate electricity based on the temperature difference that occurs during switching on and off both domestic and industrial refrigerators. To produce energy from temperature fluctuations, a material with thermal inertia properties is needed — a parameter that describes how quickly a material is able to accumulate and give off heat. The team created a carefully tailored combination of materials. The basic structure is a metal foam, made of copper or nickel, which is then coated with a layer of graphene to provide even greater thermal conductivity. Then, the foam is infused with a kind of wax called octadecane, a phase-change material, which changes between solid and liquid within a particular range of temperatures chosen for a given application.

Thus, one side of the device accumulates heat, and the other slowly emits it. One side is always behind the other while the system is trying to achieve balance. Constant fluctuations of temperatures inside one material allow to generate electricity using the principles of thermoelectricity. The combination of three materials - metal foam, graphene and octadecane - allows us to call this thermal resonator material with the highest thermal inertia known to science, writes MIT News.

A sample of the material made to test the concept showed that, simply in response to a 10-degree-Celsius temperature difference between night and day, the tiny sample of material produced 350 millivolts of potential and 1.3 milliwatts of power — enough to power simple, small environmental sensors or communications systems. 1.3 milliwatts of energy may seem tiny; however, remember when LEDs were first invented. Early prototypes gave off little more than a faint glow.

Today, they are bright enough to be used for automobile headlights and theater lighting, among other common uses. Don't scoff at a device that puts out a wimpy 1.3 milliwatt current. Think instead what it could mean for the future. Kourosh Kalantar-zadeh, an engineering professor at RMIT University in Melbourne, Australia, says. "It can potentially play an unexpected role in complementary energy harvesting units. To compete with other energy harvesting technologies, always higher voltages and powers are demanded. However, I personally feel that it is quite possible to gain a lot more out of this by investing more into the concept. It is an attractive technology which will be potentially followed by many others in the near future.” Specialists are planning to increase its capacity to ensure the ability to charge mobile devices, including smartphones. It is assumed that in the future the thermal resonator will allow electrifying remote regions.

As noted, the research was partially funded by the King Abdullah University of Science and Technology (KAUST) of Saudi Arabia. There they intend to use this technology to power the network of environmental sensors in the oil and gas fields. If the project succeeds, thermal resonators will be used in tandem with solar panels, which will provide a completely independent source of energy for the sensors. According to the developers, even if there is a sandstorm, during which solar panels are useless, resonators will be able to support the work. Earlier they wrote that NASA is seriously considering the transfer of mechanical robots with mechanical computers to Venus. Similar development for certain can be useful and there.

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GAS USING FOR PRESERVING AGRICULTURAL PRODUCTS

Carbon dioxide is one of the most important chemical compounds of human, animal, and plant lives, and environmental health. Because of several desirable characteristics of carbon dioxide in gas, solid, liquid, and supercritical states such as inertness, non-explosiveness, non-corrosiveness, high volatility, cooling ability, and low-cost, carbon dioxide is being used in a variety of applications in food and processing industries. Applications of carbon dioxide in preserving fruits, vegetables, meats, food grains, and liquid foods; inactivating microorganisms; and extracting oils, flavors, colors, and chemicals are discussed. Carbon dioxide as high pressure gas and supercritical fluid would find a niche in food and processing industries in the future especially in applications involving non-thermal sterilization and supercritical extraction.

Carbon dioxide (CO2) is the third-most abundant gas available in the air. CO2 content of the atmospheric air ranges from 300 to 600 ppm (by volume) depending on the measurement location on the earth. CO2 is an important constituent in the life cycle of animals and plants. Naturally available CO2 gas is used in the photosynthesis process by plants that are the basic sources of food. The decay (slow oxidation) of all organic materials gives off CO2. In the respiratory action (breathing) of all animals and