The world's first self-energy power road by collecting electromagnetic energy from moving object and its conjecture on the energy-mass equivalence

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Abstract

The barrier between matter and energy has been removed by Einstein's energy-mass equivalence, but how to utilize the self-energy of matter is still a difficult problem. Here, four 28 W fluorescent tube lamps can be lighted up when a car model slides on a self-energy power road (SEPR). The instantaneous power density of SEPR can reach 11.6 W/m^2, even though the results was limited by the energy collector and measuring device. An energy-velocity model was proposed to utilize the electromagnetic energy in the constantly friction between the SEPR road and the car model. The affecting factors that are related to the electromagnetic energy conversion of the SEPR were systematically studied including velocity, acceleration, contact area and friction. The results show the generated electromagnetic energy is proportional to the velocity of friction. Besides, it can be found there is a process of rapid collision in the vertical direction in the high-velocity friction. Another free fall object experiment is designed to investigate the electromagnetic energy generated by the vertical collision. Importantly, it happened that the instantaneous power is proportional to the square of velocity in the vertical collision, which happened to be consistent with the energy-mass equivalence. Similar to the energy produced by the collisions of neutrons in nuclear fission, it can be inferred that the generated electromagnetic energy will far exceed the work done by the pulling force in the high-velocity collision, and the utilization of the self-energy of matter may be the essence of electromagnetic energy conversion. The simplicity and suitability of collecting the electromagnetic energy in

motive collision was fully demonstrated by the design of SEPR based on the ceramic tile and ground, the ceramic tile and water. Moreover, the world's first SEPR was successfully built in an actual road, which opens the door for solving the energy crisis. The energy-velocity model can be also used to explain the signal interference of high-speed railway and improve the positioning accuracy of missile, considerate that the electromagnetic energy produced by the object in motion. The new discovery may contribute to modifying the existing collision theory, conservation of mechanical energy, friction theory, Maxwell's equations, and electromagnetic technology. Moreover, this study will have a far-reaching impact on classical physics, new energy, low-carbon systems and other fields.

Key words

Energy-mass equivalence; electromagnetic energy; new energy; power road

1. Introduction

The increasingly serious energy crisis between energy supply and energy consumption has always been a significant concern[1-3]. The electricity has gradually been an essential necessity of modern life since the second industrial revolution. After the electromagnetic induction was discovered in 1831, the electromagnetic induction generator is chosen as the dominant way to convert mechanical energy into electric energy. However, the conventional coal-fire thermal power plants and hydropower plant bring a series of environmental pollution and ecological destruction[4, 5]. Therefore, it is urgent to find new strategies to improve the efficiency and practicability of energy conversion[6]. More and more new types of energy resources have been exploited, including solar energy, wind energy, nuclear energy and biomass energy[7-12]. Due to the technical complexity, low conversion efficiency and high cost, it is difficult to use the new energy on a large scale.

Like the Maxwell's equations, the essence of electromagnetic energy conversion can open the door for new direction of solving the energy crisis. It has been shown

that the electromagnetic energy can be generated during the collision of any substances in previous studies[13-15]. Two small stones can be used to collide to generate electromagnetic energy and light up the LEDs[13]. The electromagnetic field can be generated when some substances like water, stone and ceramic were blown even by a tiny wind[14]. Newton's pendulum was used to simulate the elastic collision, and the electromagnetic energy can be generated from each collision between two small balls[15]. It can be imagined how huge electromagnetic energy will be generated by the high-speed collisions. Although the neutrons in atoms are very small, the atomic bombs can be detonated by the high-speed collisions of neutron streams to rapidly release a large amount of energy[16]. As for the collision of two large celestial bodies, the gravitational waves can be generated[17, 18]. According to Einstein's energy-mass equivalence, the relationship between energy and mass laid the theoretical foundation for the atomic bomb. The equivalence of self-energy and self-mass demonstrates there is huge self-energy of matter[19]. Can the huge electromagnetic energy be released by stimulating the self-energy of matter when the relative velocity of the object is large enough?

Like the energy-mass equivalence for the development of the atomic bomb, more exploration of the energy-mass equivalence is very important for utilization of self-energy of the matter. Here, four 28 W fluorescent tube lamps can be lighted up by a self-energy power road (SEPR) when a car model slides on it. The SEPR mainly consists of polymethyl methacrylate (PMMA) plat or ceramic tiles and electrode array as energy collectors. An energy-velocity model was analyzed to utilize the electromagnetic energy generated by object in motion. The open-circuit voltage and short-circuit current of SEPR based on the PMMA plate can respectively reach 4400 V and 240 μA, when it was rubbed by the friction block with PTFE film. The influence of velocity, acceleration, contact area and friction on the conversion of electromagnetic energy was investigated to find out the relationship between the work done by pulling force and energy conversion. At low velocity, the generated electric energy is approximately proportional to the velocity of collision. Besides, it can be

found there is also a process of rapid collision in the vertical direction in the process of high-velocity friction due to the uneven surface. Surprisingly, the instantaneous power is proportional to the square of velocity in the vertical collision experiment, which is consistent with the energy-mass equivalence. Therefore, it can be inferred that the generated electromagnetic energy will far exceed the work done by the pulling force in the high-velocity collision, and the utilization of the self-energy of matter may be the final essence of electromagnetic energy conversion. The SEPR based on the ceramic tiles and ground or water was designed to demonstrate the practicality of collecting the electromagnetic energy in collision. Besides, the world's first SEPR was successfully built in an actual road that 360 LEDs can be lighted up when a car was passing on it. Moreover, the energy-velocity model can be used to explain many important phenomena including the signal interference of high-speed railway and the positioning accuracy of missile. This work will have a disruptive impact on the collision theory, conservation of mechanical energy, friction theory, Maxwell's equations, and electromagnetic technology.

2. Results and discussions

Can you imagine that when a car is driving on the special designed road, the electromagnetic energy generated from the friction between the running tires and the ground can be collected to light up several 28 W fluorescent tube lamps? Less than 20% of fuel energy consumed by the automotive engine can be efficiently used to drive the vehicle, while most of the energy is dissipated in the vibration and motion[20]. We have found that where there is collision, there is electromagnetic energy generated[14]. A self-energy power road (SEPR) is designed, which mainly consists of the road (PMMA plate, ceramic tiles etc.) and electrode array as energy collector. As shown in Figure 1a, there will be a considerable output if the electromagnetic energy generated by the vehicles on the special designed road can be sufficiently utilized. Figure 1b schematically illustrated the structure and working process of the SEPR. When the car model slides on the SEPR, the corresponding

energy collector under the road can convert the generated electromagnetic energy into electric energy. As shown in Figure 1c, the electric energy collected from the friction between the car model with PTFE film and the SEPR based on the PMMA plate is enough to light up four 28 W fluorescent tube lamps without delay. (Video S1) Figure 1d shows the SEPR works under the reciprocating sliding with a friction block with PTFE film by hand. As shown in Figure 1e and Figure 1f, the output of SEPR based on the PMMA plate can reach an open-circuit voltage of 4400 V, a short-circuit current of 240 μA, and the instantaneous power density of 11.6 W/m^2. Due to the limitation of the measuring device, the actual generated electromagnetic energy should be much higher than the results.

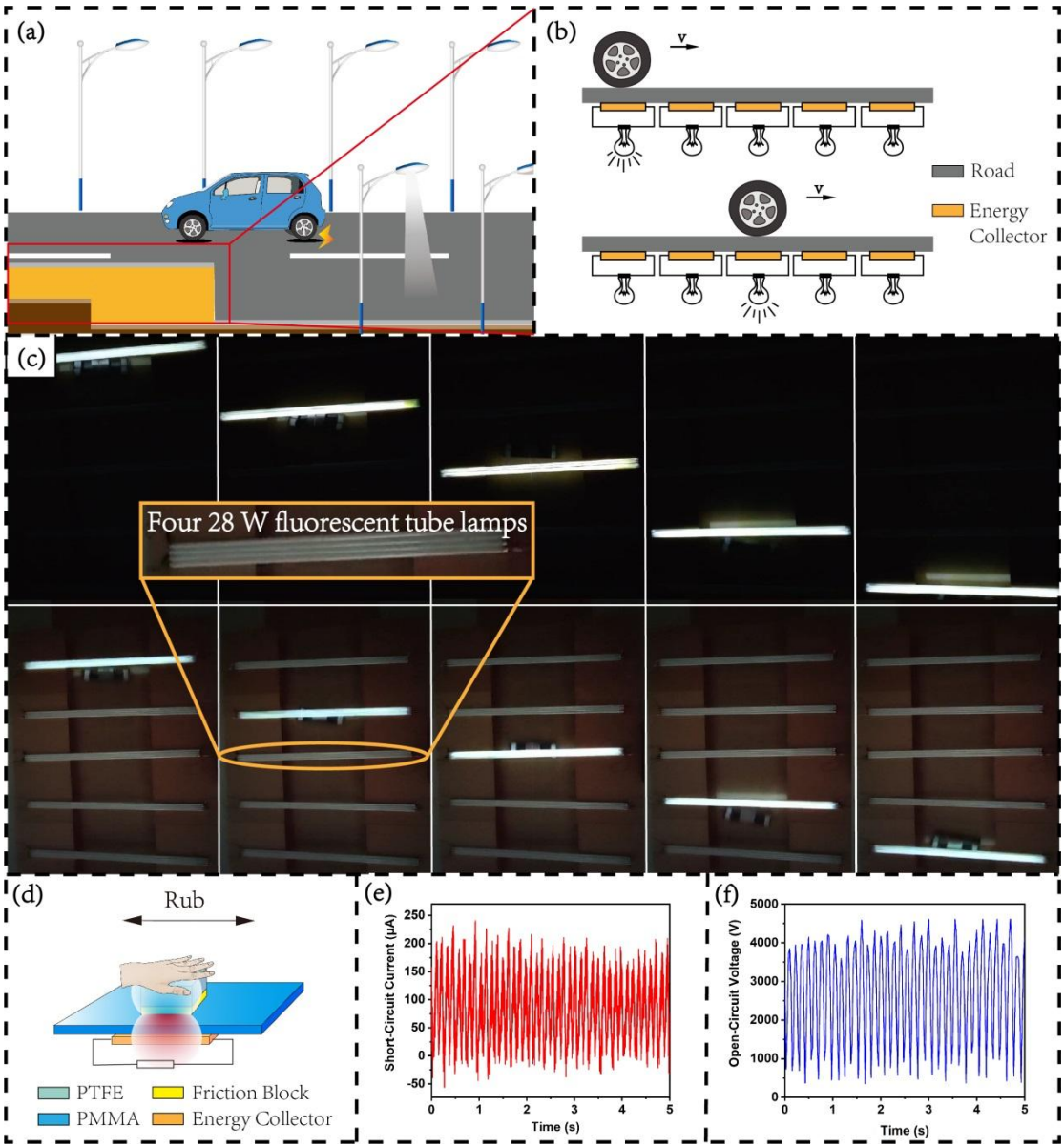

Figure 1. Structure and working process of the self-energy power road (SEPR). (a) Schematic diagram of the SEPR in the application. (b) The structure and working process of the SEPR. (c) Four 28 W fluorescent tube lamps lighted up by the SEPR based on PMMA plate. (d) The SEPR rubbed by the friction block in hand. (e) The short-circuit current and (f) open-circuit voltage of the SEPR based on the PMMA plate under the reciprocating sliding with a friction block with PTFE film by hand.

In order to verify the principle of generated electromagnetic field in the collision, an experiment of tapping a PMMA plate with a hand was designed. As shown in Figure 2a, the coil was placed at different distances from the PMMA plate to collect the generated electromagnetic energy, when the PMMA plate was tapped by hand. Points 1, 2, 3 and 4 are the same distance from the point 0. The short-circuit current of coil was measured by the electrometer. As shown in Figure 2b, the short-circuit currents of coil at the distance of 10 cm between the coil and PMMA plate (points 1, 2, 3 and 4) are approximately the same, when the PMMA plate was tapped at point 0 by hand from the left side. We accidentally discovered that the short-circuit current of coil was basically the same when the PMMA plate was tapped either by hand from the left side or by hand from right side, as shown in Figure 2c. This result reflects that the symmetrically distribution of electromagnetic fields can be generated on both sides of the PMMA plate. Besides, it has been also found that the short-circuit current of coil gradually decreased as the distance between the coil and PMMA plate increases. As shown in Figure 2d, the electromagnetic field can be generated when two objects collides with each other. One object loses energy to be in a negative energy state, and the other object gains energy to be in a positive energy state. The beginning and end of the electromagnetic field line are connected to the objects of positive and negative energy state respectively. (Figure 2d i-ii) When two objects are separated, the changing electric field and magnetic field can excite each other to propagate outward. (Figure 2d iii-iv) When two objects approach again, two ends of the electric field lines originally connected to the objects of positive and negative energy state are connected

to form loops and propagate outward. (Figure 2d v-vi) Both the electric field line and magnetic field line are generated together, which are perpendicular to the propagation direction. (Figure 2d vii-viii)

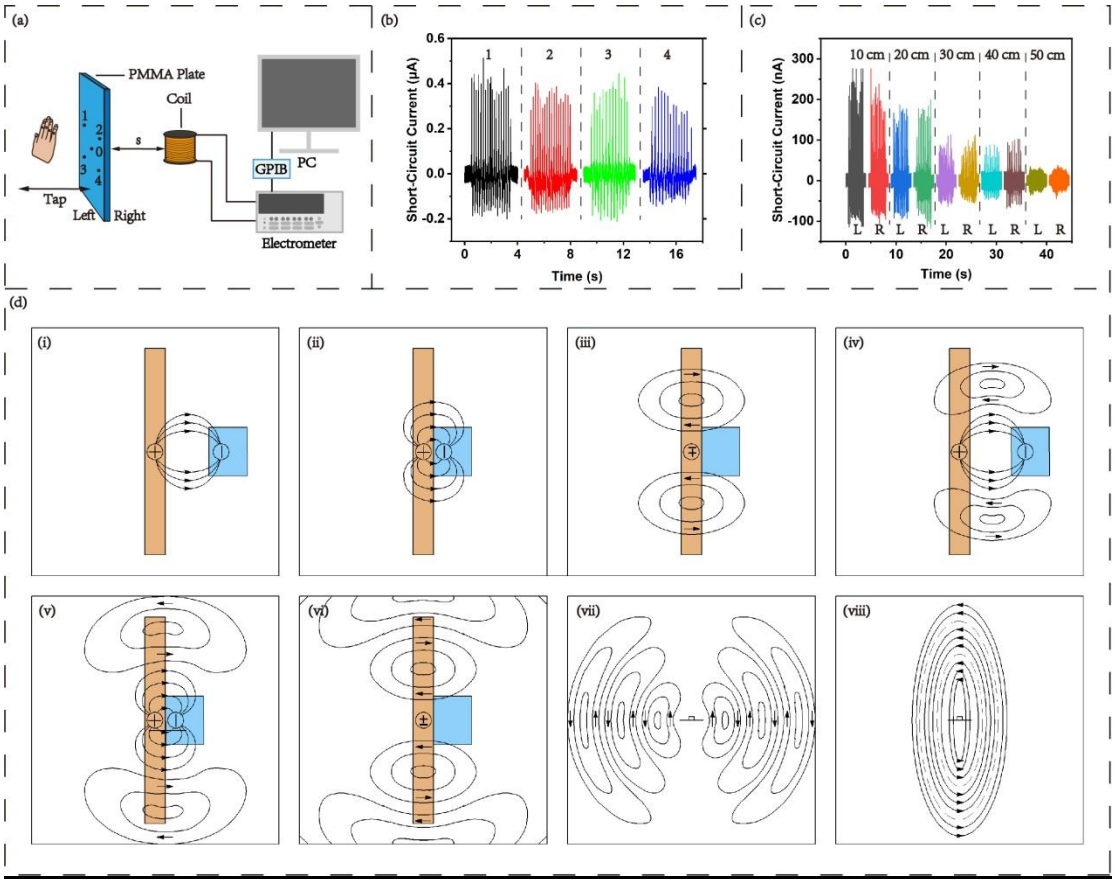

Figure 2. The generated electromagnetic field in the collision. (a) Schematic diagram of collecting the generated electromagnetic energy by coil. (b) The short-circuit current of coil at the position of the same distance from the central point when the PMMA plate was tapped by hand from the left side. (c) The short-circuit current of coil at different distances when the PMMA plate was tapped by hand from the left side or right side. (d) The changing electromagnetic field generated in the collision.

The possible working principle of SEPR is demonstrated in Figure 3a. As long as the action of force (collision, friction, contact, etc.), there will be electromagnetic field[14]. In the theory of classical electrodynamics, an accelerated charge can produce the electromagnetic radiation. According to the Maxwell's equations, there is

displacement current in the changing magnetic field or electric field. When two objects collide, the electron cloud of the surface molecules or atoms will be overlapped. Electron transition becomes easier because the repulsive force between electrons may be overcome by the force between objects. Due to the electron transition, one object tends to be positively charged and the other gets negatively charged. The displacement current has been found in the friction without electric field, and the polarization field P_s is introduced as the polarization contributed by the presence of surface polarization charges to modify Maxwell's equations. The definition of the displacement current J_D is:

$$\boldsymbol{J}_D = \varepsilon\frac{\partial \boldsymbol{E}}{\partial t} + \frac{\partial \boldsymbol{P}_s}{\partial t} \qquad (1)$$

where ε is the the permittivity of the medium; E is the electric field. The first term of displacement current has made a great contribution to the applications of electromagnetic wave. The second term is the part of the displacement current generated by the action of force in the absence of an electric field. Therefore, the electromagnetic field will be changed by any collision of objects, which results in the generation of displacement current. Take the friction of two objects as an example, the current density of the SEPR can be calculated with the following formula:

$$\mathrm{I} = \mathrm{A}\sigma_{\mathrm{T}}\frac{\mathrm{dH}}{\mathrm{dt}}\frac{\mathrm{d}_1\frac{\varepsilon_0}{\varepsilon_1} + \mathrm{d}_2\frac{\varepsilon_0}{\varepsilon_2}}{[\mathrm{d}_1\frac{\varepsilon_0}{\varepsilon_1} + \mathrm{d}_2\frac{\varepsilon_0}{\varepsilon_2} + \mathrm{z}]^2} \qquad (2)$$

where A is related to the contact surface of the SEPR, σ_T is the surface charge density, ε is the dielectric constant, H and z respectively are the distance and the farthest distance between the moving objects and SEPR, and d_1 and d_2 are the dielectric thickness. This formula shows that the current density of the SEPR is proportional to the moving velocity (dH/dt) of the friction block on the energy collector. So the changing electromagnetic field can be generated when the friction block slides on the PMMA plate, and the DC current is generated when the friction block slides over the energy collectors. Besides, the working process of conventional electromagnetic induction generator is also a special type of collision.

As shown in Figure 3b, the experimental setup is designed for measuring the output performance of the SEPR. The friction block and the PMMA plate with the energy collector were placed on the desk, and the measuring system of electrometer was connected to the energy collector. The counterweight connected to the friction block by a string is suspended as the source of pulling force. The generated electromagnetic field in the friction changes with the movements of friction block. A part of electromagnetic energy can be collected and converted into considerable electric energy by the energy collectors. Figure 3c shows the short-circuit current and current peak shape of the SEPR working in the uniform acceleration mode. It can be seen that the DC current is generated, which is consistent with above working principle (Figure 3a). Besides, the current peak of the SEPR can reach 4.5 μA, when the acceleration of friction block is 10 m/s^2. As shown in Figure 3d and Figure 3e, the open-circuit voltage and short-circuit current of SEPR can respectively reach 1400 V and 35 μA, when the friction block slides at a constant velocity of 0.57 m/s. Besides, the output of SEPR can keep constant in the peak in the constant velocity mode (the region of ii-iii in Figure 3d and Figure 3e). Therefore, the electrical output of SEPR is affected by different motion states of the moving object.

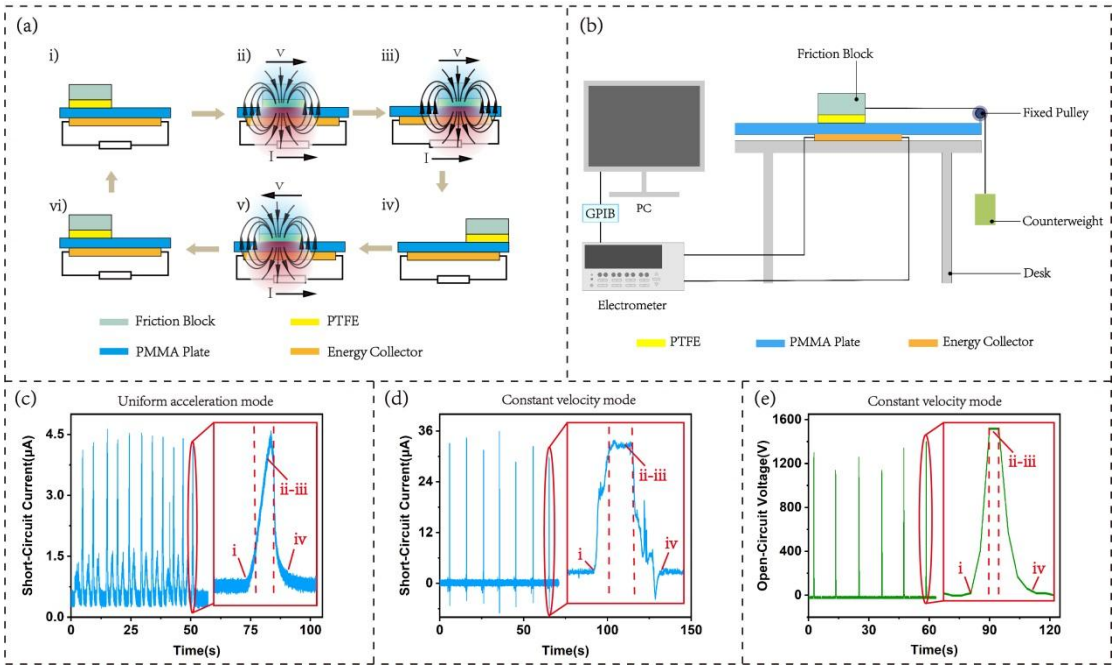

Figure 3. Working principle, experimental setup and output of the SEPR. (a) Working

principle of the SEPR. (b) Experimental setup for measuring the SEPR. (c) The short-circuit current of SEPR in the uniform acceleration mode. (d) The short-circuit current and (e) open-circuit voltage of SEPR in the constant velocity mode.

To make better use of electromagnetic energy in the friction, the influence of different conditions on the conversion of electromagnetic energy was investigated. According to the peak shape of output of SEPR in Figure 3c-3e, the electric energy generated by the sliding friction with uniform acceleration or constant velocity can be defined as follow:

$$W_{electric,\,acceleration} = \int_0^T I^2 R dt \qquad (3)$$

$$W_{electric,\,uniform} = UIt \qquad (4)$$

where I is the current, R is the external resistance, U is the voltage and t is the time that the friction block passes the energy collectors.

As shown in Figure 4a and 4c, more electric energy can be harvested by increasing the acceleration and velocity in the sliding friction. Besides, the contact area and friction are also important factors in the conversion of electromagnetic energy. Figure 4e shows that the harvested electric energy was improved by increasing the contact area of friction. It can be found that more electromagnetic energy can be generated when the contact area becomes bigger. As shown in Figure 4g, the harvested electric energy increases with the friction, but it becomes stable when the friction increases to a certain level.

In order to find out the relationship between the work done by the pulling force and energy conversion, the conversion efficiency of electromagnetic energy into electric energy η in the sliding friction could be defined as follows:

$$\eta = \frac{W_{electric}}{W_{pull}} \qquad (5)$$

where W_{pull} is the work done by an external pulling force, which can be calculated as the product of the pulling force F and the distance s. When the pulling force and the distance keep constant, the work done by the pulling force is invariable. Therefore,

the conversion efficiency of electromagnetic energy can be improved by increasing the acceleration, velocity and contact area, as shown in Figure 4b, 4d and 4f. On the contrary, Figure 4h shows the conversion efficiency of electromagnetic energy decreases correspondingly with the increase of friction due the limitation of collecting ability of energy collector. The results show that the greater the velocity of the friction, the greater the generated electromagnetic energy. The conversion efficiency of SEPR can reach up to 0.46%, when the maximum velocity of the moving friction block is 2.83 m/s. According to the formula (2), the current density of the SEPR is nearly proportional to the moving velocity. It can be assumed that the generated electromagnetic energy will far exceed the work done by the pulling force when the velocity reaches over 3000 m/s. According to the energy-mass equivalence of $E=mc^2$ ($c=299792458$ m/s), the energy of the friction block (1 kg) is about 9×10^{16} J. No great discovery was ever made without a bold guess. Similar to the energy produced by the neutron collisions in nuclear fission, it can be inferred that huge electromagnetic energy will be generated when two objects collide at an extremely high velocity.

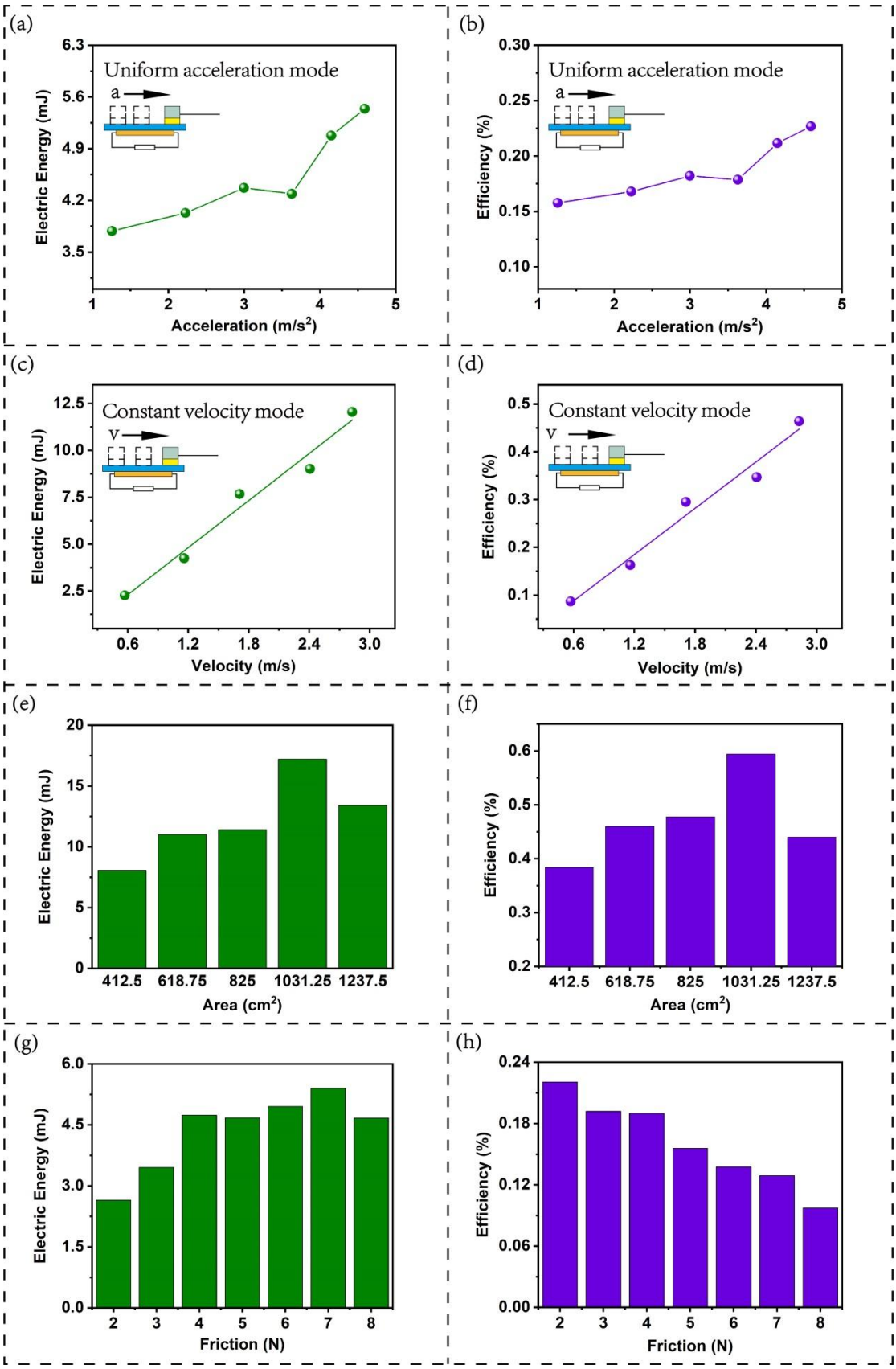

Figure 4. The conversion of electromagnetic energy into electric energy of SEPR under different conditions. (a) The dependence of the electric energy and (b)

conversion efficiency of electromagnetic energy on the velocity in the uniform acceleration mode. (c) The dependence of the electric energy and (d) conversion efficiency of electromagnetic energy on the velocity in the constant velocity mode. (e) The dependence of the electric energy and (f) conversion efficiency of electromagnetic energy on the contact area in the uniform acceleration mode. (g) The dependence of the electric energy and (h) conversion efficiency of electromagnetic energy on the friction in the constant velocity mode.

More importantly, it can be found there is also a process of rapid collision in the vertical direction in the process of high-velocity friction. As shown in Figure 5a, the contact surface of SEPR is not absolutely horizontal in the actual state, which is uneven on the microscopic level. The friction block receives the pulling force, friction, gravity and supporting force. Due to the uneven surface, the friction block not only has velocity component in the horizontal direction, but also has a velocity component in the vertical direction as shown in Figure 5b. There is also the vertical collision under the action of gravity, due to the tiny gap between the friction block and the PMMA plate. The vertical distance in the sliding friction is too small to be measured, and the velocity of vertical collision is also small, so the influence of the relative velocity of vertical collision on the generation of electromagnetic energy was investigated by a vertical collision experiment (free fall object experiment). Figure 5c shows the setup of the vertical collision experiment. Friction block was used to hit the PMMA plate under different velocities to collect the generated electromagnetic energy in the collision. It can be seen that higher instantaneous power can be obtained by increasing the relative velocity of the collision. Figure 5d and 5e show the open-circuit voltage and short-circuit current can respectively reach 140 V and 35 μA, when the velocity of collision is 12 m/s.

In fact, the collision process is essentially a process of energy transfer. At low velocity, the generated electric energy is approximately proportional to the velocity of collision. Interestingly, Figure 5f shows that the instantaneous power is proportional

to the square of velocity in the vertical collision, which happened to be consistent with the relationship between energy and velocity in the Einstein's energy-mass equivalence. According to the theory of special relativity, the relationship of the electromagnetic self-energy U_{el} and electromagnetic mass m_e can be given by

$$U_{el} = m_e c^2 \qquad (6)$$

where c is the velocity of light in vacuum. When the collision happens at a low velocity, the self-energy of objects is not large. The change of the generated electromagnetic energy is little affected by the change in velocity, so the generated electromagnetic energy is approximately proportional to the moving velocity. When the velocity of collision is relatively high, the self-energy of the object becomes larger. Although only a part of the generated electromagnetic energy can be collected due to the limitation of the energy collector, it can be seen that the power increases rapidly with velocity. Therefore, it can be inferred that the utilization of the self-energy of matter may be the final essence of electromagnetic energy conversion. No great discovery was ever made without a bold guess. It can be boldly predicted that any matter can generate huge energy like an atomic bomb, as long as the matter has a large enough velocity in the collision. Everything is in eternal relative motion and interacts with its surroundings. Therefore, there will be a lot of electromagnetic energy in the universe. However, are the working mechanism related to the gravity and dark matter?

It has been investigated that the electromagnetic field can be generated by the action of wind on different substances[13, 14]. Taking the signal interference of high-speed railway as an example, our mobile phones can be used normally and the signal is not affected when the high-speed railway remains stationary. However, when it is running at a high speed, it can be found that the signal of the mobile phone will be interfered. (Figure 5g) This phenomenon shows that the friction between the high-speed railway and the air can generate strong electromagnetic fields, which will cancel or interfere with the signal of mobile phone. Besides, this new discovery may be also used to improve the positioning accuracy of rapidly moving objects like the

missile. The analysis of the missile's trajectory that directly affects its positioning accuracy and damage effect is difficult. As shown in Figure 5h, the positioning accuracy of missile is affected by various factors, especially for the friction between the missile and the air. The conventional analysis is mainly carried out from the movement trajectory and the force situation of missile, but the energy loss in the friction is ignored. Based on the previous analysis, electromagnetic energy will be generated when the missile flies through the air at an extremely high speed. It can be assumed that the positioning accuracy of the missile may be greatly improved, if it is analyzed from the perspective of energy including the generated electromagnetic energy in the friction.

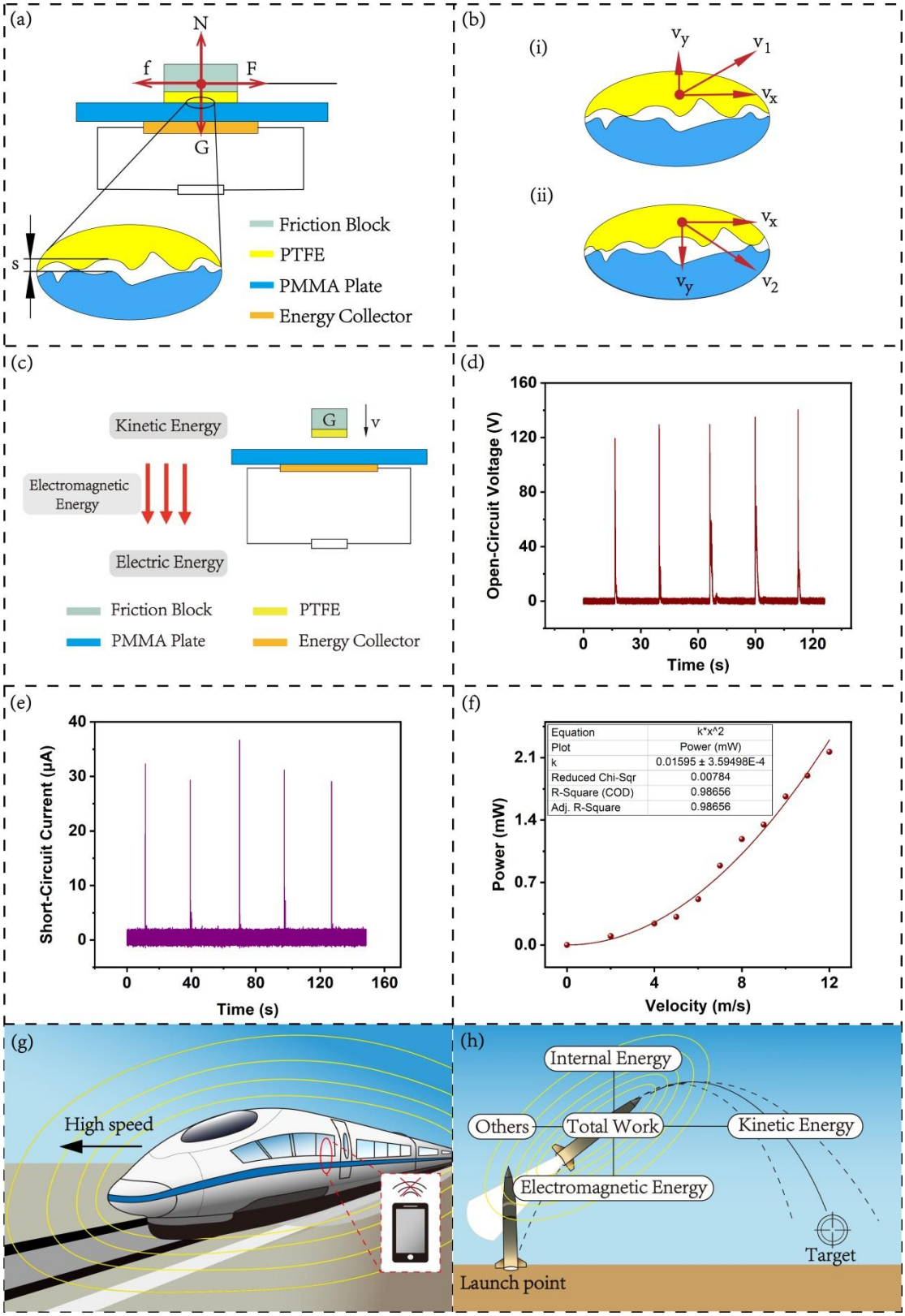

Figure 5. The influence of relative velocity in vertical collision on the generated electromagnetic energy. (a, b) Force situation and velocity analysis of friction block. (c) The setup of the vertical collision experiment. (d) The open-circuit voltage and (e)

short-circuit current in the vertical collision (velocity: 12 m/s). (f) The dependence of the velocity on the power in the vertical collision. (g) Schematic diagram of the signal interference of high-speed railway. (h) Schematic diagram of the positioning accuracy of the missile.

In order to simulate the actual road, the SEPR based on the ceramic tiles was designed to harvest the electromagnetic energy generated in the collision. As shown in Figure 6a, the energy collector was placed under the ceramic tiles that can be collided with the friction block, tire or feet with shoes. As shown in Figure 6b and Figure 6c, the open-circuit voltage and short-circuit current of SEPR can respectively reach 4100 V and 160 μA, when the ceramic tiles was rubbed by hand with the friction block with fluorinated ethylene propylene (FEP) film. A lot of electromagnetic energy will be generated when there is collision or friction due to the stimulation of self-energy of matter. As shown in Figure 6d, 360 LEDs can be lighted up by the SEPR, when a person walked or jumped on the ceramic tiles. The LEDs becomes brighter due to more electromagnetic energy when the person jumps higher. (Video S2) Figure 6e shows the 360 LEDs can be lighted up by a rolling tire on the SEPR based on the ceramic tiles. The LEDs can be brighter when the tire was rolled at a higher velocity. (Video S3)

Besides, many materials like the water can be used as the energy collector to collecting the generated electromagnetic energy produced by object in motion. As shown in Figure 6f, the ceramic tile was placed on the water to construct a simple SEPR. Figure 6g and Figure 6h, the open-circuit voltage and short-circuit current of SEPR can respectively reach 1000 V and 45 μA, when the ceramic tile was tapped by hand with the friction block with FEP film. The output of SEPR demonstrates good capability and suitability of water as the electromagnetic energy collector. As shown in Figure 6i, 360 LEDs can be lighted up by the SEPR, when a person stepped on the ceramic tile above the water. (Video S4) The SEPR based on the ceramic tiles and water fully demonstrates the practicality of collecting the electromagnetic energy in

collision, which is consistent with the above energy-velocity model.

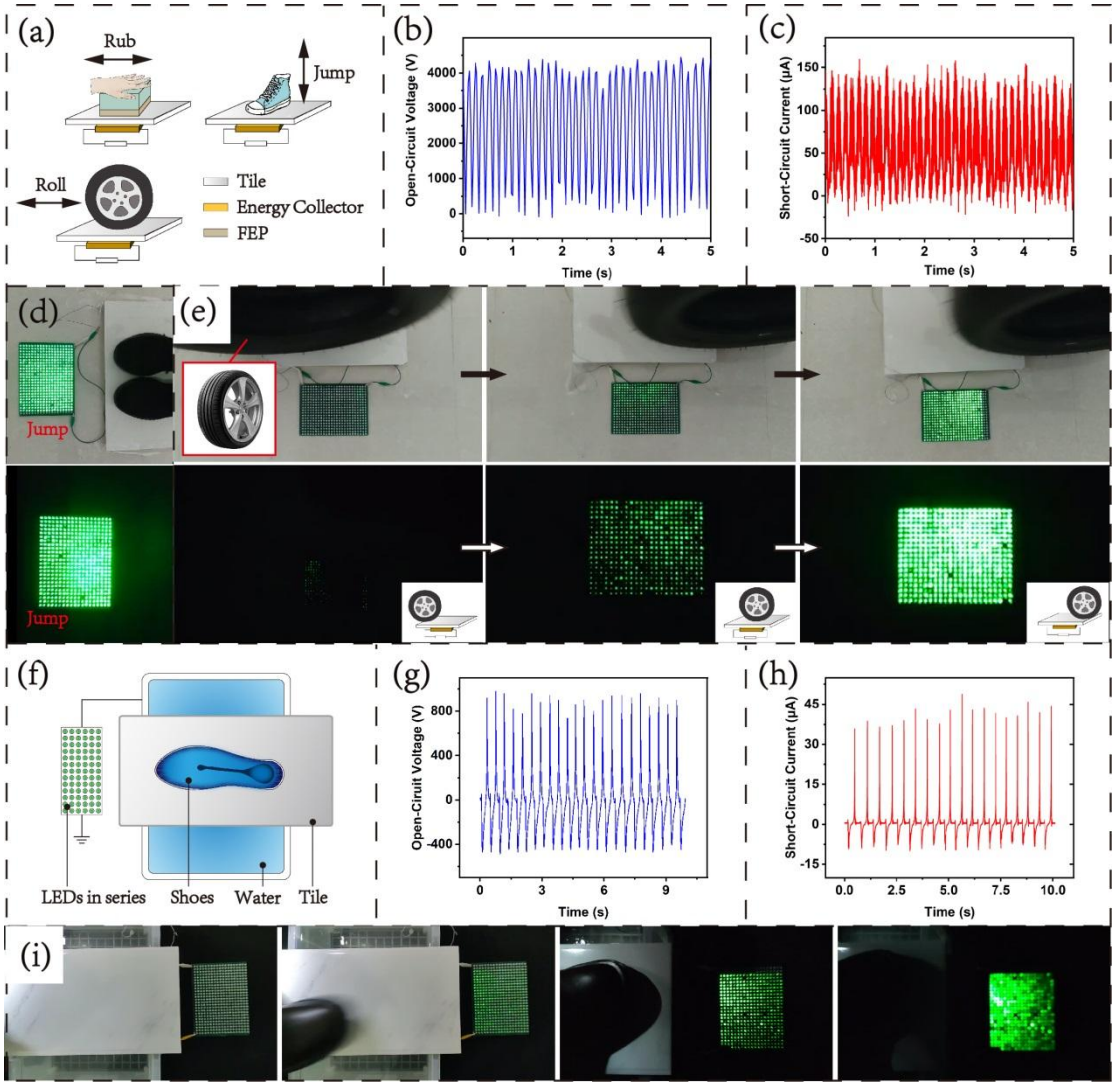

Figure 6. The SEPR based on the ceramic tiles and water. (a) Schematic diagram of the experimental setup of SEPR based on the ceramic tiles. (b) The open-circuit voltage and (c) short-circuit current of SEPR based on the ceramic tiles rubbed by the hand. (d) 360 LEDs lighted up by the SEPR based on the ceramic tiles when a person jumped on it. (e) 360 LEDs lighted up by a tire on the SEPR based on the ceramic tiles. (f) Schematic diagram of the experimental setup of SEPR based on the ceramic tiles and water. (g) The open-circuit voltage and (h) short-circuit current of SEPR based on the ceramic tiles and water when it was tapped by the hand. (i) 360 LEDs lighted up by the SEPR based on the ceramic tiles and water when a person stepped on it.

Furthermore, the world's first SEPR built in an actual road was designed to harvest the electromagnetic energy generated in the friction between the running tires of automobile and the road. As shown in Figure 7a, 360 LEDs were connected to the SEPR based on the PMMA plate that can convert the generated electromagnetic energy into electric energy. Due to the excellent performance of the SEPR, 360 LEDs can be easily lighted up when the toy car ran on the SEPR back and forth. (Video S5) More importantly, Figure 7b shows the world's first SEPR was successfully built in the actual road, which is the practical application on the stimulation of self-energy of matter. As shown in the inset, the PMMA plate and concrete was mixed to build the road, and the energy collectors were embedded into the concrete. Figure 7c shows the tire of a car is in contact with the world's first SEPR. As shown in Figure 7d, the light board of 360 LEDs can be lighted up by the passing car on the world's first SEPR. (Video S6) If the SEPR is built larger or into array, more electromagnetic energy generated by the vehicles on the road can be collected.

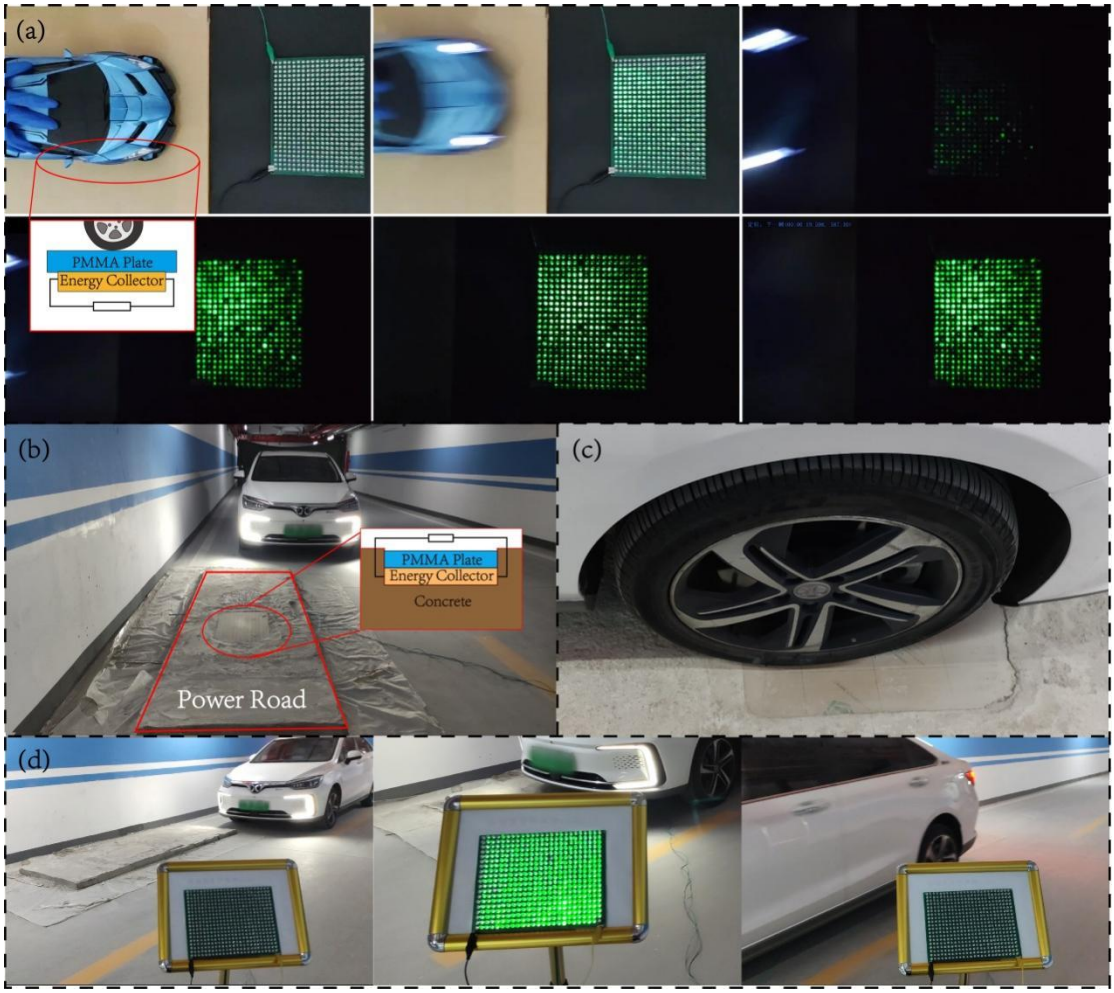

Figure 7. The world's first SEPR on the actual road. (a) 360 LEDs lighted up by a passing toy car on the SEPR. (b) The world's first SEPR built in an actual road. (c) The tire of car in contact with the SEPR. (d) 360 LEDs lighted up by the passing car on the actual road built with SEPR.

3. Conclusions

In summary, a simple SEPR based on the energy-velocity model was designed to harvest the electromagnetic energy generated in the friction and collision. At least four 28 W fluorescent tube lamps can be lighted up by the electric energy collected from the friction between the car model with PTFE film and the SEPR. The output of SEPR can reach an open-circuit voltage of 4400 V, a short-circuit current of 240 μA, and the instantaneous power density of 11.6 W/m^2, but the actual generated electromagnetic energy is much higher. At low velocity, the generated electric energy of SEPR is

approximately proportional to the velocity of collision. Besides, a collision experiment was designed to deeply explore the relationship between the electromagnetic energy generated in a collision and the relative velocity. Importantly, it can be found that the instantaneous power is proportional to the square of velocity in the vertical collision, which is consistent with the energy-mass equivalence. Just as the nuclear fission can be detonated by the collisions of neutrons at high speeds, it can be inferred that more electromagnetic energy can be generated and converted into electric energy when there is a greater relative velocity of collisions. That is to say, the utilization of the self-energy of matter may be the final essence of electromagnetic energy conversion. Many important phenomena may be explained by the energy-velocity model, including the signal interference of high-speed railway and the positioning accuracy of missile. The SEPR based on the ceramic tile and ground or water demonstrates the simplicity and suitability of collecting the electromagnetic energy in collision. Moreover, 360 LEDs can be easily lighted up by the world's first power road as long as the car passes on the SEPR. The SEPR not only has a considerable output by harvesting the electromagnetic energy generated by the vehicles on the road, but also provides a new method for the utilization of the self-energy of matter. From the electromagnetic energy collection in collision to experimental conjecture based on the energy-mass equivalence, this work will have a far-reaching impact on classical physics, new energy, low-carbon systems and other fields.

4. Experimental methods

Fabrication of the SEPR based on the PMMA plate

The SEPR was prepared by placing the electrode array as the energy collectors on the bottom of PMMA plate. The friction blocks were prepared with PTFE film attached to five sizes of acrylic plates. The friction block was pulled by a string connected to a motor or counterweight.

The design of the experimental setup for measuring the output performance of the SEPR

The acrylic box is used as a counterweight to provide the constant pull force under the condition of uniform acceleration mode. A resistor of 1000 MΩ was connected to measure the output power of the SEPR. Additional weights of different masses were placed in the friction block or counterweight to control the friction. In the constant velocity mode, the friction block was carried by a motor to move at a constant velocity.

The design of the vertical collision experiment

The energy collector and PMMA plate were placed on the ground to collect the electromagnetic energy, and the friction block with PTFE film were dropped from different heights to obtain different velocities.

Fabrication of the SEPR based on the ceramic tiles and water

The energy collector was placed under the ceramic tiles to collect the electromagnetic energy, and the energy collector was connected to the LEDs. Besides, the ceramic tiles were placed on the water as the energy collector to construct a simple SEPR. When the person stepped and jumped or the tire rolled on the ceramic tiles, the LEDs can be lighted up.

Electrical measurement

The current was measured by an electrometer (Keithley 6514) with computer measurement software written in LabVIEW. The voltage was measured by a oscilloscope (Agilent DSO1012A).

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