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Capturing Atmospheric Ions Using Static Electricity from Flowing Water

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Abstract

Air pollutants carrying positive charges are believed to be harmful to health. This paper proposes the use of flowing water for neutralizing the positively charged pollutants into a DC electricity. In this work, atmospheric ions are captured on ground levels using an antenna designed to operate at ultraviolet frequency bands. The antenna is negatively charged by a static electricity extracted from flowing water. The output is a DC voltage dependent on the density of the atmospheric positive ions. The proposed system generates 480mV in the absence of an UV light if the antenna is connected to the negative ion source. When exposed to an UV light, it generates 680mV. Without the negative ion source, however, the output voltage fell to around 10 mV and no significant voltage rise can be observed even in the presence of an UV light. Conclusions: Flowing water can be used to capture atmospheric ions.

Keywords: **Cosmic Rays, Surface Plasmon Polariton, Surface Plasmonic Resonance. Kelvin Water Dropper, Kelvin Thunder**

1. Introduction

Air pollutants are known carriers of positive atmospheric ions. At low altitudes, positive atmospheric ions mainly come from positively charged dusts, bacteria, pollen, chemicals, primary or secondary cosmic particles and fumes. Positive ions tend to promote oxidative damage to the human body. The human body naturally carries negative charges. As such, it is naturally attracted to atmospheric positive ions when the body is exposed to air pollutants. There have been published studies on the association between shortage of negative ions in the body and ailments, including headaches, and/or fatigue [1-3]. In 2013, the International Agency for Research on Cancer (IARC) even classified these particulates as a harmful carcinogen [1]. The IARC has convincingly demonstrated an increasing risk of lung cancer with increasing levels of exposure to air pollutants and particulates. For health sake, it is imperative to remove the positive ions from our atmosphere. Out of this concern, this paper presents a technology for capturing positive atmospheric ions. With the proposed methodology, the buildup of these excessive positive ions can be neutralized and turned into an energy when they are attracted to negative electricity extracted from flowing water.

2. System for Harvesting Positive Atmospheric Ions

It is imperative to identify at which frequency bands the atmospheric ions are most active and mobile. Fig. 1 shows a spectrum of cosmic radiations against atmospheric opacity. It is known that lights with frequencies below the ultraviolet band cannot ionize air molecules. From Fig. 1, however, ultraviolet radiations are the only frequency band at which ionizing energy can make its way through the atmosphere [4]. Gamma- or X-rays from the galaxy are powerful enough to ionize air molecules in the upper atmospheric but they are almost completely filtered out by oxygen and ozone before reaching the ground. At lower atmosphere, a large portion of the atmospheric ions are induced by cosmic ray as a result of a process known as cosmic cascade. However, ultraviolet lights are still the main activator of the atmospheric ions at low altitudes.

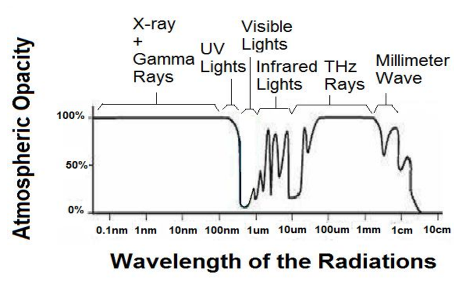

Fig 1. Atmospheric opacity of different cosmic radiations [4]

For the reasons as stated above, the system for capturing positive atmospheric ions should focus on capturing atmospheric ions at the ultraviolet frequency band. The proposed atmospheric ion collector consists of two basic building blocks, i.e. an UV antenna and a negative ion source (see Fig. 2).

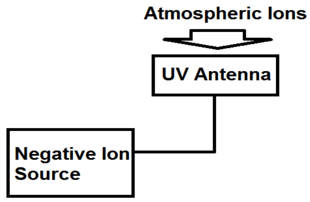

Fig. 2 Building Blocks of the Proposed Atmospheric Ion Collecting System

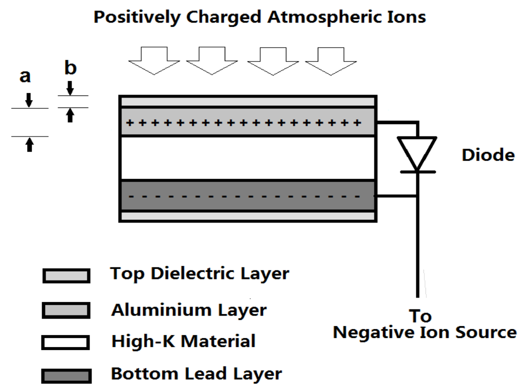

Fig. 3 UV Antenna.

UV Antenna

To harvest the maximum amount of atmospheric ions, the antenna should be designed in such a way that it collects not only ultraviolet lights, but also electrostatic charges floating in air. These two criteria can be easily met by following the following strategies:

3.1 The incoming UV light should be captured in the form of surface electromagnetic waves, also known as surface plasmon polariton. Unlike space wave, which is distributed all over the three dimensional space, surface electromagnetic wave propagates mainly along the two dimensional interface between a metal and a dielectric. Either aluminum or silver should be used as the metal for capturing ultraviolet lights because these two metals naturally have a surface plasmonic resonance frequency right at the ultraviolet band.

3.2 The metal for the antenna (that is, aluminum or silver in this case) should be biased to a negative voltage to attract the nearby atmospheric protons. In this work, this metal is indirectly connected to a natural source of negative charges which does not rely on any external energy supply to operate.

3.3 The current induced by the incoming radiations must be directed from the positive end, which is the antenna in this case, towards the negative end, which is the source of negative charges. In this work, this is done using a high frequency rectifying diode.

Fig.3 shows the cross-sectional view of the proposed UV antenna.

Positive atmospheric ions are expected to electrostatically attracted to the top surface if the antenna is connected to a negative ion sources. In addition to these ions, UV radiations from the sun or other secondary cosmic particles also play a role in ionization. The fast-moving cosmic particles will be slowed down significantly as they pass through the top dielectric layer. These radiations are ionizing and they induce an energy which is mainly electromagnetic in nature. This electromagnetic energy can either be trapped as a result of the intrinsic localized surface plasmon resonance in aluminum or be propagated as a surface electromagnetic wave along the interface between the top dielectric layer and the aluminum layer. Surface electromagnetic wave can propagate more efficiently than the conventional electromagnetic wave because the latter tends to be radiating whilst the former does not.

The efficiency of this surface plasmon polaritan can be optimized by making sure the antenna reaches the surface plasmonic resonance. According to [5], surface plasmon resonance can be attained when the leaky modes (or radiating modes) are minimum and the propagation modes are maximum. In the structure as shown in Fig. 3, the top dielectric layer and the aluminum layer must fulfill the criteria specified in Eqs 1 and 2.

$$\varepsilon_a a_a + \varepsilon_b a_b = 0 \quad (1)$$

$$\frac{k_a}{\varepsilon_a} + \frac{k_b}{\varepsilon_b} = 0 \quad (2)$$

where ε_a and ε_b are respectively the dielectric constants of the dielectric coating and the aluminum layer. a_a and a_b are respectively the thicknesses of the dielectric coating and the aluminum layer. The dielectric constant of aluminum is obtained according to the Drude's model. At UV-C frequencies, the dielectric constant of aluminum is about -12. Dielectric constant of the top dielectric layer is approximately 3. The aluminum thickness *b* is about 100 microns. According to Equation (1), the top aluminum layer is coated with a layer of 30 micron thick PMMA.

4. Negative Ion Source

To neutralize the atmospheric positive charges accumulated on the top of the antenna, there must be a corresponding source of negative ions. In this work, this negative ions source can be generated through frictions between two insulators. The idea of the proposed negative ion source is borrowed Kelvin's water thunder [6]. Unlike the original Kelvin's water thunder, which usually stops working when the water buckets are fully filled, the proposed negative ion source is single tube device capable of continuously generating a static electricity out of flowing water. As the water continues to flow, the proposed negative ion source can continue to operate without any interruption and without any external energy supply. The water can flow from natural sources, including waterfalls, springs, heavy rainfall, tidal waves or rivers.

Fig. 5 illustrates the experimental prototype modeling the system for harvesting atmospheric ions. The sub-system highlighted by the boxed area on the left is the proposed negative ion source used to generate a negative voltage with respect to the ground. In Fig. 5, the ends of the plastic tube act as the water inlet and the water outlet. The regions in the neighborhood of the water inlet and the water outlet are respectively fastened with metal ring A and metal ring B. These metal rings never touch any water. Between these two metal rings, pin A and pin B are nailed into the plastic tube. Pin A and pin are both immersed into the water inside the plastic tube. Pins A and B must be made with a metal resistant to rusting. Pin A is wired to metal ring B, whilst pin B is wired to metal ring A.

In Fig. 5, running water through the plastic tube will generate a static electricity in the interior of the plastic tube. This static electricity are not evenly distributed. If the water in the neighborhood of metal ring A is positively charged, pin A will carry a positive potential while metal ring A will be electrostatically induced to negative. Because Pin A is connected to metal ring B, the water at the region close to metal ring B and pin B will be negatively charged. The wire connection between pin B and metal ring A forms a positive feedback which continuously maintains their negative potential. For exactly the same reason, the wire connection between pin A and metal ring B forms another positive feedback, maintaining their positive potential. If pin A is connected to the faucet, which usually carries electric charges, the electric charges in the flowing water will continuously manifest as a source of negative ions for the UV antenna on the right.

4. Experimental Results and Discussions

We have constructed the prototype as shown in Fig. 4. and its performance has been measured with and without a sunlight in the eleventh floor of a building based in Shenzhen. A voltmeter (RIGOL DM3051) was used to measure the voltage between metal ring A and the aluminum layer of the UV antenna as shown in Fig. 4 at different times of the day. The same measurement was repeated every lunch break and evening throughout the last month of autumn. During the measurement, all the sources of electromagnetic disturbance have been removed , or placed very far away from the proposed system, as to rule out any possibility of any non-cosmic energy source. Our findings are summarized in the following table:

Table 1: Measured voltage between the antenna and pin B when the water was running at 150 cm 3 per second.

Situations	***Final Voltage (V)***	***Comments***
With an UV light	0.68	Voltage reached the peak within 15 seconds
Without an UV light	0.48	Voltage reached the peak within 15 seconds

The voltage between pins A and B of the negative ion source was very stable and it tends to increases when the water flow rate increases. When water flow rate increases, the final voltage between metal rings A and B also increases with approximately a delay of 15 seconds. This is due to the fact that the amount of atmospheric ions that can be harvested is positively associated with quantity of negative charges from the negative ion source.

When the bottom lead plate was disconnected from the negative ion source, however, the output voltage fell to around 10 mV and no significant voltage rise was observed even in the presence of an UV light.

The voltage between the top aluminum layer and the ground connection was successfully used to charge up a 470 uF capacitor.

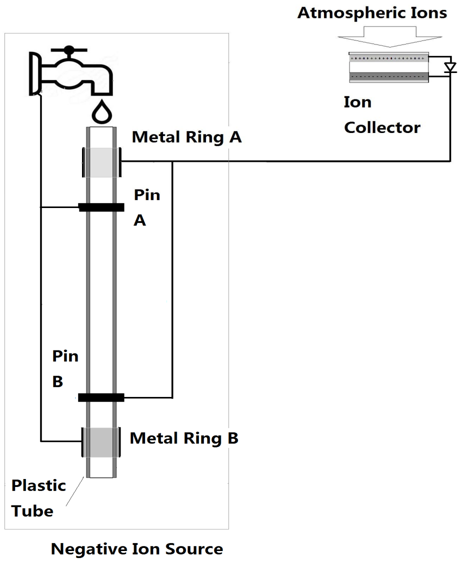

Fig . 4. Schematic view illustrating the prototype modeling the whole atmospheric ions collecting system

4. Conclusions

This paper has presented a system for harvesting atmospheric positive ions using a static electricity extracted from flowing water. Measurement has been carried out with and without any UV lights. The experimental system successfully generates 0/68 volts in the presence of UV light and 0.48 volts in the absence of any UV light. The experimental results suggest that atmospheric ions can be cost-effectively harvested to an observable extent without any external energy supply. There is a positive association between the harvested energy the water flow rates.

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Louis WY LIU graduated from University of Leeds, UK, with a PhD in 2002 and First Class Honors Degree in Electrical and Electronics Engineering from Sunderland University in 1989. During his PhD candidature, he was also a research engineer in Agilent Technologies. He was postdoctoral research fellows in University of Michigan from 2001 to 2003. From 2003 to 2008, he founded a company to commercialize a patented nanofabrication technologies under a UK government funding award. He was teacher and environmental activist from 2008 to 2015. From 2015 to now, he is a research fellow in Southern University of Science and Technology. His research interests include surface electromagnetic waves, terahertz science, nanotechnology and energy science.