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Design of pollution preventing system for camera window

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Abstract

This research is focused on the development of a window protection system to prevent pollution of a glass, mirror, or camera lens. For this, a new method for efficient pollution prevention was designed and the characteristic evaluation for developing the system was partly performed.

Formerly, the method of using an air purge was generally used for preventing pollution of a camera window. However, the conventional method often induces contaminations due to back flow of air purging. These pollutants can do crucial damage to the camera window and peripheral materials especially in clean room condition. And the conventional method always requires an air supply; therefore, it is difficult to apply the method where an air source cannot be supplied such as a traveling crane located at mountain altitudes. Moreover, the frequent air purging operation or maintenance-personnel intervention causes window surface damage.

To solve the above-mentioned problem, an efficient concept for preventing such pollution is proposed in this research. Without air purging, we proposed a new method using repulsion induced by electrifying dirt or moisture to positive magnetic force with high-voltage charge and then injecting gas to the ITO (Indium Tin Oxide) coated window for generating positive ion. In support of the superiority of the designed method for pollution prevention of a window, key factors for permeability and photographing test were defined and partly evaluated as compared with the conventional method.

To sum up, in this research, we aim to develop an efficient pollution preventing system for a camera window based on a new method through characteristic evaluation and stabilization of the designed system.

Keywords: Protecting system; Pollution; Camera lens; Air purging; Voltage charge

1. Introduction

This research is about a device that can protect glass or lens. It is about a window contamination protection system to protect monitors, glass, mirrors or video camera lenses from moisture and dust that are included in the atmosphere. With the use of windows, mirrors, video or cameras, etc., surfaces become contaminated after a certain amount of time passes because of atmospheric dust or moisture. Until now, such contaminated surfaces have been cleaned by using water or air [1, 2].

But video cameras and monitoring cameras installed at buildings, streets, parking lots or cars are easily contaminated by dust created from their surroundings. There has been the inconvenience of having to clean them often, and many problems have occurred such as lenses becoming damaged. Especially, many cameras installed at chemical or steel manufacturing companies and special places such as paint coating facilities are not easily accessed, are difficult to clean regularly, have problems such as reentrance of contaminating substances followed by air cleaning or water cleaning. This occurs even if one tries to take care by blowing with air, and the situation is that air cleaning is difficult to apply at places where cameras are installed at moving cranes, etc.

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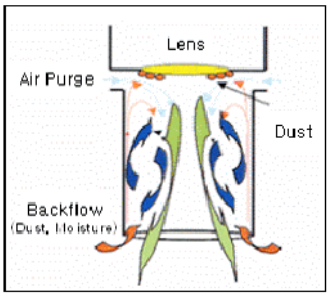
because of necessity to supply air. Also, in the purified environment of precision parts such as semiconductors where the maintenance of purity is required, the use of air method has plenty of opportunities for spreading contamination to other precision equipment or precision processed goods [2-4].

Therefore, we are trying to develop a commercialized model of a lens window contamination-preventing device by a new concept of applying the method of charging the incoming dust or moisture by ionizing the spray type gas after permitting high voltage. In other words, we are trying to build a mass production infrastructure through a camera window contamination preventing module device and production of test product by using electrical repulsive force. This charges the incoming dust or moisture as positive by using a camera window coated with conductive transparent film (ITO, Indium Tin Oxide), which is already being supplied to form a positive high voltage and ionizing the spray type gas in order to prevent contamination from scattered dust or moisture.

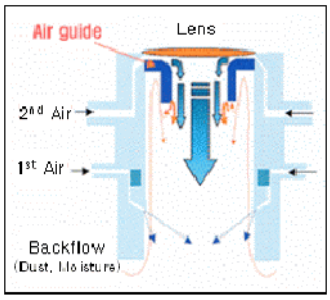
2. Analysis of related research

Three main types can be mentioned as examples of related researches that have been performed previously. First, the problem of using air purging as in (a) of Fig. 1 is the reentrance of contaminated air from back flow followed by air purging. Second, there is the method using secondary air purging like (b) of Fig. 1 to make up for the former. It involves intercepting the reentrance of contaminated air from back flow with secondary air. But there is a problem in that it is inappropriate to apply to sites where the air cannot be supplied easily, such as high-rise cranes and highways or at an environment that needs to maintain purity like the Semiconductor Materials Laboratory [5, 6]. For a method that 'does not use air, we can mention the outline drawing of a glass cleaning device as in Fig. 2. This is the content described in Japanese public patent 2005-279620; the glass and electric body are connected to a power supply while the glass has permitted positive voltage and the electric body has permitted the negative voltage. The dust or moisture in the atmosphere entering into the electric field formed at the front of the glass by permitted voltage are charged as positive, and negative voltage is absorbed as the permitted charged body.

Ordinarily, it is not easy to permit voltage to dielectric substances, and even if high voltage is permitted,



(a) Air purging method



(b) 2nd air purging method

Fig. 1. A structure map of contamination prevention by air purging.

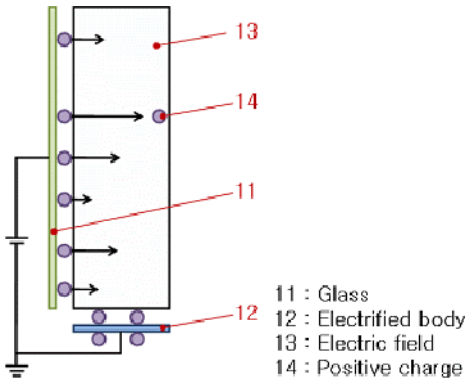


Fig. 2. Contamination prevention structure map presented in japanese patent.

there are not many positive ions released in proportion to the voltage. Thus, there is a disadvantage in that the strength of the electric field is not strong enough to charge the dust or moisture created in unpaved roads or during rainy season in great quantities. Also, in case of thick dielectric substances such as glass, a higher voltage is needed in order to form an

electric field. This requires a vast amount of energy and can cause death from electric shock if people or cattle come near it. Furthermore, if a great quantity of dust or moisture is absorbed, there is the disadvantage of the glass getting contaminated again by dust or moisture entering from the outside.

In order to solve this problem, this research has set its purpose in providing window contamination prevention system using a gas ion generating device which sprays ion gas of same polarity as the voltage permitted to the transparent conducting film formed at the window.

3. Design of camera window contamination prevention device

In an environment with a large amount of dust or moisture, a camera window contamination prevention system that can effectively prevent camera contamination from dust and moisture being scattered at surroundings while using factory processed monitoring camera or front and rear cameras for automobiles is shown in Fig. 3. The system includes a window fastened to a housing and forming a transparent conducting film, power supply unit for permitting positive or negative voltage to the above transparent conducting film, and a gas ion generation unit spreading ion gas with the same polarity as the voltage permitted to the above transparent conducting film on the entire surface of the window.

If an example of practical application is explained in detail by referring to the unit number marked on Fig. 3, it is as follows. It illustrates the window contamination prevention system of a video camera followed by an example of the practical application of this research.

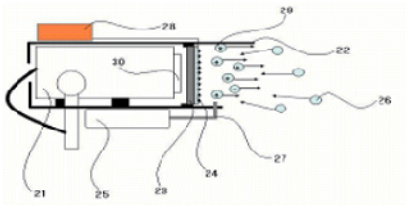


Fig. 3. Contamination prevention device structure map of new method.

If we were to explain based on the numbers indicating items in the picture, video camera (21) is sealed by camera housing (22). The lens of video camera (21) of window (30) located in front of window (23) is fastened by camera housing (22) to intercept dust and moisture entering from the outside. For the material of window (23), any one of a transparent high molecular compound film, glass, crystal or sapphire is used and the transparent conducting film (24) is coated or applied at one side of the window contacting the outside atmosphere.

4. Proposed contamination prevention mechanism

The contamination prevention mechanism of thedevice attempted to be developed and the concept established in this research is as follows. It is explained by using the term number of each item indicated on Fig. 2.

- The window (23) located at the front of lens (30) of camera (21) is made to intercept dust and moisture entering from the outside because it is fastened by housing (22).
- Any one of the transparent high molecular compound film, glass, crystal or sapphire is used as material of the window, and the transparent conducting film (24) is coated or applied at one side of the window contacting the outside atmosphere.
- ITO is used for transparent conducting film and one among the macromolecules of the polythiophene series is used as conductive organic compound.
- For the power supply unit (28), permit the necessary power in order to charge the transparent conducting film by attaching it to the top of the camera housing.
- Place the gas ion-generating unit (25) at the bottom of the camera housing, and the gas molecule is ionized by high voltage charge, or electrons released from heated filament ionize gas molecules as positive.
- The gas ion generated from gas ion generating unit is sprayed to entire surface of the window through gas tube (27) and the sprayed positive ion gas is absorbed to dust or moisture particles (26) moving toward the window.
- For dust or moisture particles charged as positive ion, the repulsive force is acted upon with transparent conducting film (24) charged as positive

and moved once again to the atmosphere without being able to reach the window (23).

Therefore, the window (23) is able to maintain its clean condition.

5. Experiment results

The experiment device structure map is like Fig. 4, and a contaminating substance removal test was performed like Fig. 5. For the external diameter of copper plate, while Ø30 and Ø50 have been used, the experiment was centered on Ø30 because the one with small diameter is ideal to apply in the automotive field, such as a rear monitoring camera although the diameter of video devices at industrial sites is Ø50 and there was no change of performance followed by difference of external diameter. As the result of the test, the removal effect of dust or contamination substances was high as the distance between pole and grounding was closer like Table 1.

Table 1. Dust removal ratio experiment results.

Distance between Poles and Grounding	Voltage (V)	1000	2000	3000	4000	5000
5 ㎜	Dust Removal Ratio (%)	0	5	10	60	100
4 ㎜	Dust Removal Ratio (%)	0	20	40	80	100
3 ㎜	Dust Removal Ratio (%)	5	40	60	95	100
2 ㎜	Dust Removal Ratio (%)	10	50	70	100	100

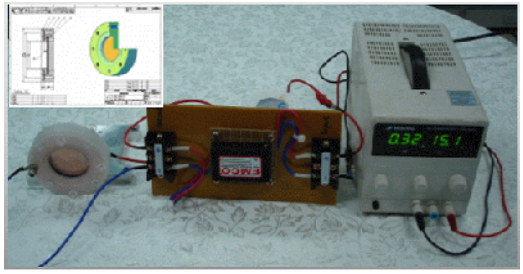


Fig. 4. Prototype Experiment Device Structure.

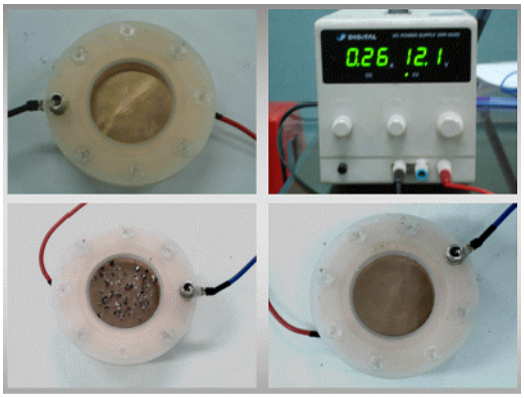


Fig. 5. Contamination prevention test screen.

6. Conclusion

In this research, the basic design was accomplished of a camera window contamination protection module device that can effectively prevent camera contamination from dust and moisture being scattered at surroundings in using front or rear cameras for automobiles and factory process monitoring cameras, such as steel manufacturing factories in environments with considerable dust or moisture. The window contamination protection system in this research has the advantage that it can protect camera lenses effectively from contaminating substances such as dust or moisture charged by a gas ion generating unit by permitting voltage to the window that has formed a transparent conducting film.

Therefore, it can be applied effectively to cameras for road monitoring and control, front and rear monitoring of automobiles and other special purposes besides industrial equipment and process monitoring. Especially in the case of a window contamination protection system installed at a production line of poor conditions, an improvement of productivity and economic profit is expected to be gained by solving problems like difficulties in supplying air and regular cleaning.

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