

## Study on Surface Flashover of PTFE

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**Abstract.** In this paper, the surface flashover characteristics of polytetrafluoroethylene (PTFE) under normal atmospheric pressure are studied. The DC power supply voltage is measured under the condition of different pole spacing, and the discharge voltage waveform and current waveform are recorded. In addition, under the same experimental conditions, the air breakdown voltage of the two electrode corresponding to the pole spacing is measured and compared with that of the Teflon surface flashover. The results show that the surface flashover voltage increases with the increase of the electrode spacing, but the surface flashover strength decreases. The surface flashover voltage of PTFE is much smaller than that of the air breakdown voltage, and the air breakdown field strength does not change with the change of the pole spacing.

### 1. Introduction

In early twentieth Century, people found surface flashover. And soon people found on the satellite surface also exist surface flashover. Flashover is a serious threat to the safe of the satellite. Therefore, it is of great significance to study the flashover characteristics of insulator. At present, at home and abroad, the research on the characteristics of the surface flashover has been carried out. Scholars have proposed many models of surface flashover discharge of dielectric materials. Among the many models, the second electron emission avalanche model (SEEA) and the electron triggered polarization relaxation model (ETPR) are the most recognized by the scholars [1]. In the SEEA model, it is easy to form a distorted electric field at three points. The initial electrons are generated here and two electrons are produced on the surface of the material under the external applied electric field. There are a lot of positive charges on the dielectric surface after the two electron emission. In the process of the positive charge of the dielectric surface area, the two electron emission collapse has also been produced. The electrons move toward the anode, and the positive charges move toward the cathode. This strengthens the electric field in the region, leading to the two electron emission and so on [2]. The electric field in the region was strengthened, resulting in the two electron emission collapse being strengthened. In addition, the surface of the medium is desorbed and ionized. The ETPR model shows that there are defects in insulation materials [3]. The charge trap at the influence of external electric field and polarization to escape under medium. These cause flashover.

### 2. Experiment

#### (1) PTFE surface flashover test

The electrode distances were respectively 1mm, 2mm, 3mm, 4mm, 5mm. Applying the voltage to the upper electrode of the sample with the increasing speed of 100V/s. The surface flashover voltage and current waveform are recorded by oscilloscope. After the surface flashover occurs, stop the pressure and return to zero. The electron cyclotron resonance (ECR) plasma potential controller was used to eliminate the sample. Test for 15 times between each group

(2) Take the same two PTFE plate, the distance between two plates is 1mm, 2mm, 3mm, 4mm, 5mm. The electrode is pressurized at the speed of 100V/s until the breakdown discharge occurs. Recording the discharge voltage and current waveforms using an oscilloscope.

### 3. Experimental Result

#### 3.1 DC Air Breakdown and Surface Flashover Characteristics

Air breakdown current, voltage waveform as shown in Figure 2.1, figure 2.1 (a) is the current waveform, figure 2.1 (b) is the voltage waveform.

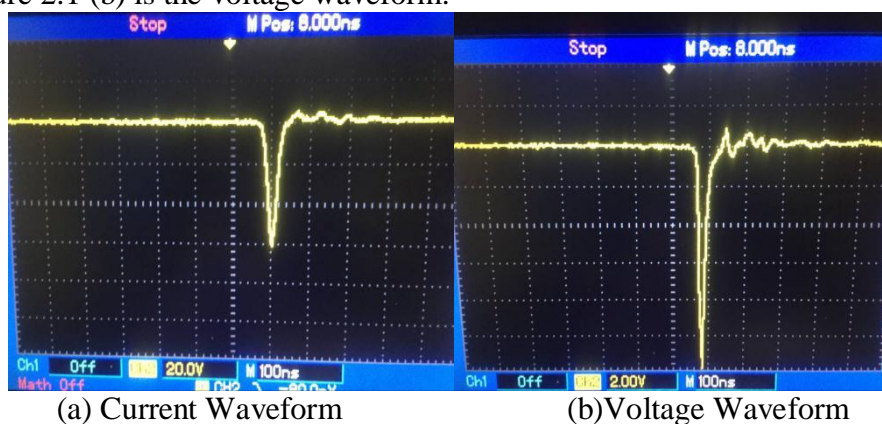


Figure 2.1 Air breakdown current and voltage waveform

Surface flashover current and voltage waveform of PFTE is shown in Figure 2.2, Figure 2.2 (a) is the current waveform, Figure 2.2 (b) is the voltage waveform.

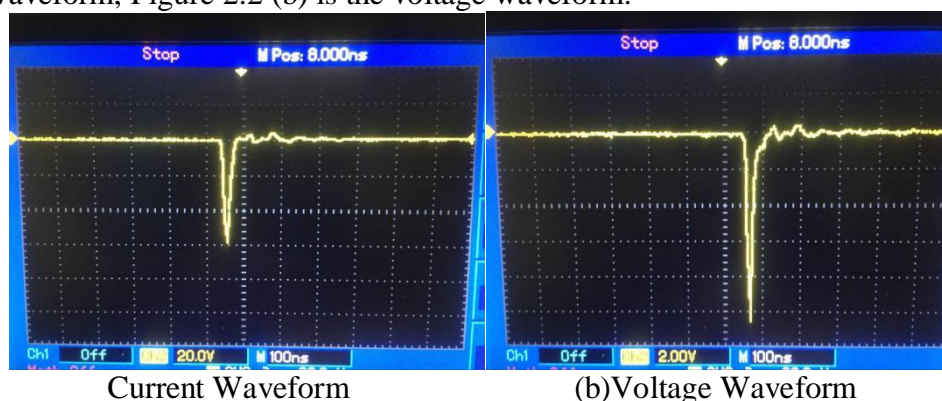


Figure 2.2 Waveform of surface flashover current and voltage

From figure 2.1 and Figure 2.2 shows that when the electrode spacing under the same condition, the flashover voltage is far less than the air breakdown voltage, and breakdown current is greater than the flashover current.

#### 3.2 The Relationship Between Pole Spacing and Surface Flashover

The experiment found that the surface flashover voltage is different under different interelectrode spacing, when the electrode spacing is 1mm, the minimum flashover voltage, is about -3kV. When the pole spacing is 5mm, the maximum surface flashover voltage of about -11kV. Overall, two electrode spacing increases along the surface the flashover voltage increases, but the inter electrode spacing and the voltage is not a linear relationship; in addition, the surface flashover voltage and the average field strength are not consistent with the increase of the interelectrode spacing.

#### 3.3 Flashover Voltage Variation

Flashover discharge voltage changes with the number of experiments as shown in figure 2.3.

With the increase of the number of experiments, the flashover voltage increases first and then tends to be stable. It is found that the surface roughness of dielectric is changed with the increase of the number of flashover.

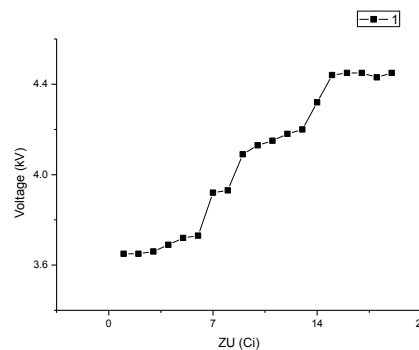


Figure 2.3 Variation of flashover voltage along with the number of experiments

## 4. Analysis and discussion

### 4.1 Effect of Pole Spacing on Discharge

It is found that the change of the pole spacing has little effect on the air breakdown discharge. This is because the experiment uses small spacing. For a slightly inhomogeneous field in small gap, the dispersion is very small. In addition, the electrode used in the experiment is the electrode and the DC power supply. These conditions are more concentrated in the breakdown discharge region. There is no influence on the air breakdown field strength. Compared with the air breakdown discharge, the flashover voltage increases with the increase of the space between the two electrodes, but it increases nonlinearly. The flashover field strength is negatively correlated with the pole spacing.

### 4.2 Effect of Dielectric Surface on Surface Flashover

According to the experimental data and the research of North China Electric Power University, it is found that the surface roughness of dielectric medium has a direct relationship with the flashover voltage. The larger the roughness is, the less the electrons move toward the anode <sup>[4]</sup>. Due to the weakening of the two electrons, the flashover voltage becomes higher. With the increasing of the number of flashover, the surface of the dielectric will hardly change. Therefore, the flashover voltage of the surface appears to increase first and then tend to be stable.

## 5. Conclusion

1) When the electrode spacing is constant, the two electron emission and the gas desorption effect occur in the process of surface flashover. This promotes the establishment of ion channels between anode and cathode. Therefore, in the same environment, the surface flashover voltage is less than the air breakdown voltage

2) With the increase of electrode spacing, the voltage of surface flashover and air breakdown increased. However, because of the increase of the space between the electrodes, the space between the electrodes increases and the electric field inhomogeneity increases. In the small gap, due to the discharge is concentrated, so the breakdown discharge field strength will not change with the gap.

3) The roughness has an important influence on the flashover voltage. With the repetition of flashover, the flashover voltage increases first and then becomes stable. The reason is that the surface roughness of dielectric medium is changed, and the roughness increases, which hinders the formation of the electron motion and the two electron avalanche.

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