JOSHI-EFFECT AND THE H. F. COMPONENTS

By G. V. BAKORE

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ABSTRACT. The theory of Joshi-effect, as proposed by Deb and Ghosh is shown to be inadequate. It is pointed out that the occurrence of both the positive and the negative Joshi-effect is possible on Joshi's theory consistent with the findings of Klemenc, Hinterberger and Hoffer.

Results of Warburg and Leithauser (1903) indicated the presence in the discharge current of frequencies much higher than that of the exciting field. Klemenc, Hinterberger and Hoffer (1937) have shown that the h. f. components of the discharge current originate from the neutralisation of surface charges when the exciting potential is passing through its zero value. Since the surface charges are deposited on the dielectric surface (*e.g.* the glass walls) the neutralisation takes place in a number of sparks between small isolated elements of the surface charges. Joshi (1944) has observed that decrease in the discharge current under irradiation is associated with the suppression of these high frequency components. Deb and Ghosh (1946-47, 1948) have offered an explanation for the suppression of the h. f. components under light. According to these authors (1946-47) "The effect of light is to restrict the formation of the surface charges on the glass walls. This is because the electron-affinity of the glass surface is small and even the red light has sufficient energy to detach the electrons from it." In a later paper these authors (1948) remarked "The surface charges are deposited not directly on the surface of the glass walls but rather on the adsorbed mono-molecular layer of the contained gas which is formed on the dielectric surface. The surface charges will therefore be quickly and more completely formed if the electron-affinity of the gas molecules is high. Hence the greater the electron-affinity of the gas used, the greater will be the proportion of the h. f. components (produced by the discharging of the surface charges) in the total current and the greater the percentage reduction".

If the surface charges are deposited on the adsorbed layer of a gas of high electron-affinity, the detachment of electrons by ordinary light will be difficult and the effect will therefore be least in case of a gas of high electron-affinity. The effect, on this theory, should therefore be least and not greatest, as has been argued in case of chlorine. In addition, the statements of the authors are in themselves contradictory.

Other drawbacks of the Deb-Ghosh's theory are that the occurrence of the positive Joshi-effect and that of the irreversible negative Joshi-effect recently observed by Marathe and Bemmannver (1950) cannot be anticipated from the theory.

Earlier, Joshi (1946) advanced a theory to explain the phenomenon. According to him: (1) under the electric discharge, an activated layer is formed on the electrodes and it is in dynamic equilibrium with the excited gas phase ; (2) as a primary step, photo-electrons are emitted from the active layer and (3) the photo-electrons are converted into slow moving negative ions due to the electron-affinity of the excited gas molecules ; these negative ions account for the effect.

The theory is not inconsistent with the findings of Klemenc *et al* (1937). The liberation of the photo-electrons from the active layer reduce the surface charges, thus reducing the intensity of the discharge pulses. The conversion of these photo-electrons into slow moving negative ions increases the sparking potential of the surface charges. The increase in the sparking potential suppresses the discharging of the reduced surface charges when the exciting potential is passing through its zero value. It is obvious that the magnitude of the increase in the sparking potential will depend on the negative ions formed and therefore on the electron-affinity of the excited gas. The suppression of the h.f. components will therefore be more complete with increasing electron-affinity of the excited gas. This accounts for the maximum % Δi in chlorine.

The conversion of the electrons into negative ions will be permanent at low electron energies and therefore should be favoured at low x/p or/and with light of low frequency. It is therefore expected that the irreversible negative Joshi-effect should occur at low exciting potentials and with light of low frequency. This is actually observed.

If, however, the liberated electrons are not converted into slow moving negative ions of low mobility, they will reduce the sparking potential of the surface charges by ionisation by collision and thus facilitate the discharging of the surface charges with a consequent increase in the current. This is the positive Joshi-effect. The probability of electron-attachment decreases at large electron energies and also with the decrease in the electron-affinity of the excited gas. It is therefore only to be expected that the positive Joshi-effect will occur with a gas of low electron-affinity as also at large x/p or/and with light of high frequency as observed.

On this basis it is clear that the net effect Δi will be the algebraic sum of $-\Delta i$ due to negative ion formation and $+\Delta i$ due to ionisation by collision caused by the liberated photo-electrons.

Joshi's theory (1946) thus gives a more detailed picture of the mechanism of the light-effect consistent with the findings of Klemenc, Hinterberger and Hoffer (1937).

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DEPARTMENT OF CHEMISTRY,
MAHARAJA'S COLLEGE, JAIPUR

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