Diagnostics of plasma formed during the oxidation of hydrocarbons in shock waves by electric probes with a conductive and dielectric surface

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Abstract. Experiments were carried out behind shock waves with recording the electric current flowing through cylindrical probes with a conductive and dielectric surface under a negative (-9V) potential relative to the walls of the shock tube, with the displacement and total currents measured, respectively. Simultaneously, the signals of chemiluminescent emission from electronically excited OH* (λ = 308 nm) and CH* (λ = 430 nm) radicals were recorded. Experiments were carried out with various lean mixtures of methane and acetylene with oxygen diluted in argon. Preliminary calculations were performed using a theoretical model of an electric probe with a dielectric and conducting surface. Simulations showed that the displacement current on a probe under a negative potential with a dielectric surface is controlled by the chemical ionization rate, the surface area of the probe, and the electric potential. A close correlation was observed between the times of reaching the maximum of the probe current and the maximum of the chemiluminescent emission signals from the electronically excited OH* and CH* radicals.

1. Introduction

During the combustion of hydrocarbons in flames and their oxidation behind the shock front, plasma is formed due to the processes of chemical ionization [1–6]. For its diagnostics, electrical probes of various designs with a conducting surface are widely used [7–9]. As our preliminary experiments show, electrical probes with a non-conductive dielectric surface are much less sensitive to various uncontrolled processes that usually occur on the catalytic surface of a conductive probe. The problem is presented by the theoretical interpretation of the experimentally measured probe currents. Probe measurements are influenced not only by elementary processes occurring in the plasma region adjacent to the probe, but also by processes on the probe surface (emission, reflection, formation of surface films). All these factors significantly complicate the quantitative interpretation of probe measurements. In the overwhelming majority of cases, experimentalists deal with conduction currents...
of positive and negative ions and free electrons. For a stationary low-temperature plasma with a relatively slow source of thermal ionization, this is quite justified. However, in the case when charged particles are formed in fast reactions of chemical ionization, a very noticeable contribution to the total current to the probe, which is usually recorded in experiments, is made by the displacement current. The displacement current is not directly related to the transfer of charges in space during their directed motion in an electric field, but is due to a change in the electric field strength near the probe surface with time as a result of the formation of an electric double layer when charged particles appear in the reacting system. It can be expected that the displacement currents recorded by electric probes with an insulated surface will be much less sensitive to ionization processes with the participation of various impurities on the surface of the electric probe and will be sensitive only to chemical ionization processes in the reaction mixture in the gas phase, leading to the formation and change in time of the electric double layer near the probe surface. The aim of this work was to conduct experimental and computational studies of the behavior of cylindrical probes with both conducting and non-conducting dielectric surfaces placed in a plasma in which chemical ionization processes take place with the formation of free electrons and ions of different types during the oxidation of various mixtures of hydrocarbons with oxygen in argon behind reflected shock waves and comparison of the probe signals with the signals of chemiluminescent radiation of electronically excited OH* (λ = 308 nm) and CH* (λ = 430 nm) radicals.

2. Experimental

The experiments were carried out on a shock tube made of stainless steel with an inner diameter of 75 mm, with a high-pressure section 1.5 m long and a low-pressure section 3.2 m long [10]. The low-pressure section was evacuated with a 2-NVR-5D fore-vacuum pump through a trap with liquid nitrogen to a residual pressure of 10⁻² Torr. The residual pressure was monitored using an ionization thermocouple vacuum gauge VIT-2. The high-pressure section was evacuated with a 3-NVR-1D fore-vacuum pump through a trap with liquid nitrogen to a residual pressure of 0.1 Torr. Air leakage into the low pressure section did not exceed 10⁻⁴ Torr / min. Before each experiment, the low-pressure section was flushed twice with argon used to prepare the mixtures, with intermediate pumping down to 10⁻¹ Torr.

The test mixtures were prepared manometrically and stored in light-tight glass containers. Acetylene (dissolved, grade A), methane (pure grade, 99.9%) and oxygen (99.0% purity) were used as components. The diluent gas was argon (99.998% purity). When preparing acetylene-containing mixtures for acetylene, additional purification and chromatographic control of purity were carried out [11]. The mixtures under study were strongly diluted with argon. In quantitative measurements of ionization processes under typical shock tube conditions, the level of possible impurities is very important. It was shown in [12] that in experiments with “pure” argon the following components are the main pollutants: 40% H₂O, 50% N₂, 5% CO₂, and 5% hydrocarbons (mainly CH₄). The oxygen concentration was below the sensitivity limit of the mass spectrometer. It was shown in [12] that the concentration of iron atoms Fe is negligible and only the presence of sodium chloride NaCl molecules should be taken into account. The concentration of NaCl molecules in the shock tube was estimated from 4 × 10¹⁰ to 5 × 10¹¹ cm⁻³. In our experiments, we used the following working mixtures: 0.005C₂H₂ + 0.995Ar, 0.005C₃H₄ + 0.025O₂ + 0.97Ar and 0.005CH₄ + 0.025O₂ + 0.97Ar, 0.0075CH₄ + 0.03O₂ + 0.9625Ar.

Helium served as the driving gas. Since the diaphragms ruptured at almost the same pushing gas pressure, the temperature behind the incident or reflected shock wave could be further adjusted by diluting the driving gas (helium) with air: the lower the temperature to be reached behind the shock wave, the higher the percentage of added air must be.

The parameters of the gas behind the incident and reflected shock wave were calculated from the initial pressure, the mixture composition, and the velocity of the incident shock wave using the theory of ideal gas flow in a shock tube [13]. The velocity of the incident shock wave was measured on two measuring bases with three pressure sensors. The distance between them was 528 and 281 mm,
respectively. Pressure sensors with a sensitive element 1 mm in diameter were made of piezoelectric ceramics (lead zirconate titanate).

The chemiluminescent emission of electronically excited OH* ($\lambda = 308$ nm) and CH* ($\lambda = 430$ nm) radicals was also experimentally measured. The emission signals of electronically excited OH* radicals ($\lambda = 308\pm2.5$ nm) were recorded in the same section with electric probes at a distance of 11 mm from the shock tube end. For excited OH* and CH* radicals, the indicated spectral interval was isolated using a DMR-4 double quartz monochromator. The OH* and CH* radiation detector was FEU-39 photomultiplier tubes.

In a separate series of experiments, electric probes were installed at a distance of 15 mm from the end of the shock tube. In this case, in our experiments, the total electric current to the probe with an electrically conducting surface and the displacement current to the probe with an electrically insulated surface were simultaneously recorded in the same measuring section of the shock tube behind the reflected shock wave. No mutual influence of these signals was observed. Two electrical probes were used (the first probe was a stainless steel wire 0.01 cm in diameter, and the second probe was a copper wire coated in the factory with a thin layer of insulator 0.012 cm in diameter with an insulation thickness of 0.001 cm), which were installed crosswise and perpendicular to the shock tube axis in the measuring section at a distance of 15 mm from the shock tube end. The probe, covered with a layer of insulator, measured only the displacement current. A voltage of $-9$ or $+9$ V was applied to the probes with respect to the grounded walls of the shock tube.

The choice of the potentials of the electric probes in our experiments was due to the following circumstances. The potential $-9$ V is negative enough to be relatively far from the floating potential, which defines the boundary on the current-voltage characteristic of the probe between the region of a sharp increase in current when the potential moves towards positive potentials and the region of saturation currents of positive ions. The potential $-9$ V falls into the region of a noticeable change in the total current with a change in the potential, and it is still far from the region of saturation currents of ions, when the dependence of the current on the potential practically disappears. As for the positive potential of $+9$ V, since we could never ensure measurements of undisturbed electron currents in our setup due to the impossibility of quickly removing excess positive ions from the studied plasma region, the choice of the $+9$ V potential was simply due to the ease of use in our experiments with ready-made electrical elements providing a stable potential of either $-9$ or $+9$ V.

### 3. Electric probe method

An electric probe is a small metal electrode placed in a plasma and used to determine its characteristics. It typically measures the current-voltage (probe) characteristics of a system that includes a measurement probe, a counter probe (reference electrode), and a voltage source. The reference electrode can be either one of the gas-discharge plasma electrodes, or a specially introduced reference probe, or the conducting wall of the installation. If the system meets the requirements, the electric probe can be used to determine the concentration of charged plasma particles, the distribution of electrons in energy (velocity), the plasma potential near the measuring probe, potential pulsations and charged particle fluxes. After appropriate modification, the electrical probe method can also be used to study chemical processes in plasma, such as plasma chemistry, polymerization, and etching. Unlike most other diagnostic methods, the probe method gives local values of plasma characteristics.

Unfortunately, the use of electric probes for plasma diagnostics faces a number of difficulties that limit the advantages of the method associated with its apparent simplicity. The probe and the plasma must satisfy a number of relatively stringent requirements, and only in this case the results of simple electrical measurements can be unambiguously related to the plasma parameters. This also imposes significant restrictions on the size of the probes, which is associated with the perturbation of the plasma probe and the fulfillment of the requirements of the probe theory, and the need to take into account the change in the plasma potential and a number of other restrictions. In addition, the probes are introduced into the plasma using various insertion devices, so it is necessary to take into account their disturbing effect on the plasma. The use of the method of electrical probes must be justified on a
case-by-case basis, otherwise both incorrect measurements and erroneous interpretation of these measurements may occur.

During probe measurements, various processes can occur on the surface of the probe: gas adsorption, deposition of conducting, semiconductor and dielectric films, removal of deposited coatings under the action of flows of charged and excited particles from the plasma, as well as due to heating of the probe, etc. Contamination sources are either chemical compounds, present in a gaseous environment, or vapors of organic compounds formed in the discharge when using oil pumps for pumping out, as well as substances that evaporate from the walls of the discharge chamber or other installation and from objects placed in the plasma. Consequently, the properties of the probe surface in plasma differ from the properties of the probe material and change with the measurement time. The effect of contamination on the current-voltage (I – V) characteristic of the probe is due to the fact that the formed layers change the probe impedance, and also to the fact that the work function of the probe surface can change [9].

The sensitivity of the probe to contamination depends on the probe material. In each case, it is necessary to analyze the nature and strength of the effect of pollutants on the results of probe measurements. One of the important problems of probe diagnostics is the problem of the criteria for probe contamination, since it is difficult to draw any conclusions about the presence of contamination based on the shape of the current-voltage (I – V) characteristic and its derivatives.

In a discharge system where the probe surface can be contaminated, pulsed measurements are often beneficial. They are less sensitive to contamination due to their higher capacitive impedance; in addition, the surface of the probe does not have time to change over short periods of time.

The appearance of coatings on the probe and changes in its surface are considered as a phenomenon that complicates measurements. However, the sensitivity of the probe to the state of the surface makes it an effective tool for studying the processes of plasma-chemical polymerization and etching.

Electric probes as diagnostic facilities of low-temperature plasma have a number of advantages, the main of which are the simplicity of experiments and the ability to determine local parameters. Unfortunately, there is no general theory of electrical probes suitable for interpreting the results of probe measurements over a wide range of conditions.

The parameters characterizing the mode of probe operation (i.e., the mode of current passage in the near-probe region) are quite numerous. The modes of probe operation are usually subdivided depending on the ratio between the ion and electron mean free paths under elastic collisions \( \lambda_i, \lambda_e \) and the linear size of the near-probe region of perturbation. To simplify the consideration, we will assume that the thickness of the near-probe space charge layer is not greater (in order of magnitude) than the characteristic probe size \( a \) (this assumption is valid if the Debye-Huckel screening radius is comparable with the probe size or less, and the probe potential is not too large). Consequently, the probe size \( a \) can be regarded as the linear scale of the near probe region of disturbance.

For \( \lambda_i, \lambda_e >> a \) collisions in the near-probe region are insignificant. These operating conditions of the probe are referred to as collisionless or molecular conditions. The theory of these modes has been developed. In the twenties, the main results are presented in well-known works [8, 9, 14]. It should be noted that in this case the current-voltage characteristic of the probe also contains information on the unperturbed electron distribution function in addition to information on such parameters as, for example, the concentration of electrons in the unperturbed state.

For \( \lambda_i, \lambda_e \leq a \), the important kinetic scales are the relaxation length of the electron energy as a result of collisions with neutral particles \( \lambda_{en} = \lambda_e/(\delta)^{1/2} \) and the maxwellization length due to electron-electron collisions \( \lambda_{en} = \lambda_e(\nu_{ee}/\nu_{ee})^{1/2} \) where \( \delta \) is a parameter characterizing the energy transfer from electrons to neutral particles (for elastic collisions this parameter is equal to the value of the double ratio of the electron mass to the mass of a neutral particle, for inelastic collisions it is equal to the same value multiplied by the coefficient of inelastic losses), \( \nu_{ee}, \nu_{en} \) are the local values of the frequency of elastic collisions of electrons with neutrals and the frequency of electron-electron collisions (it is assumed
that the plasma is weakly ionized and \( v_\text{ion} \gg v_\text{e} \). It should be noted that usually \( \delta \ll 1 \) and therefore \( \lambda_u \gg \lambda_\epsilon \); in the considered case of a weakly ionized plasma also \( \lambda_m > \lambda_e \).

In the opposite limiting case, when at least one of the lengths \( \lambda_u, \lambda_m \) is much less than the probe size, \( \lambda_u, \lambda_e \ll (\lambda_u^{-1} + \lambda_m^{-1})^{-1} \ll a \), collisions in the near-probe region are more significant process. Obviously, there is no correlation between the current-voltage (I–V) characteristic of the probe and the type of unperturbed electron distribution function in this case; on the other hand, the unperturbed distribution function under these conditions should differ slightly from the Maxwell function. To describe the distribution of both ions and electrons in most of the near-probe region (outside a layer with a thickness of the order of \( (\lambda_u^{-1} + \lambda_m^{-1})^{-1} \)), the hydrodynamic approximation can be used. These modes of operation of the electric probe are called continuum modes or hydrodynamic modes [9].

Experiments in reflected shock waves with electric probes have several advantages. In the ideal case of a gas flow in a shock tube, the gas mixture under study is at rest behind the reflected shock wave. Therefore, in the first approximation, all the effects associated with the motion of the plasma can be neglected. As our experiments on measuring ionization in mixtures of various hydrocarbons with oxygen have shown, the peak of the probe current to the probe at a negative potential is achieved in the region of maximum chemiluminescent radiation of the reacting mixture, and the magnitude and half-width of this peak are determined by the rate of chemical ionization process. The characteristic time of this process depends on the temperature, but it is always much shorter than the characteristic time of thermal ionization. At relatively low temperatures, thermal ionization processes do not manifest themselves in any way. However, with an increase in temperature behind the front of the reflected shock wave, the current to the probe begins to increase again after reaching a maximum associated with the process of chemical ionization. The theory predicts a smooth increase in the current with time in the case of the development of thermal ionization processes. However, experiments with cylindrical probes show that the current to the negative probe after the first pronounced maximum is very often irregular. The frequency of these irregularities in the probe current increases with increasing temperature. The idea arose that these irregularities are associated with ionization processes proceeding directly on the probe surface. To check this assumption, it was decided to conduct experiments with cylindrical probes identical in size, one of which would have a conducting surface, and the surface of the other would be covered with a thin non-conducting film. Both probes would be placed in the same measuring section of the shock tube and the same negative potential with respect to the grounded walls of the shock tube would be applied to them. A probe with a conducting surface will record the total current, consisting of the displacement current and conduction currents of positive and negative ions and free electrons, while a probe with an insulated non-conducting surface will only register the displacement current associated with a change in the electric field near the probe surface due to the formation and further change of a double electrical layer. Experiments and simulations show that during the experiment in reflected shock waves, the electric probe of the considered cylindrical geometry with a diameter of the order of tenths of a millimeter remains practically cold, and the dielectric coating is not destroyed.

Our present work is devoted to experiments with such electric probes.

As correctly noted by the authors of [14], the method of electric probes is a simple and effective facility to obtain information on the local parameters of the plasma. Its advantages are manifested in the relative simplicity of the measuring equipment, in the locality and variety of the measured parameters, as well as in the sufficiently high accuracy of the measurement results. For the experimental determination of the electron energy distribution function, the distribution of potentials and electric field strengths in space, and the characteristic relaxation times in plasma, the electric probe method is practically the only one possible.

The main disadvantage of the probe method is that it is an intrusive one. In the case of a collisionless plasma, when the mean free path of particles in the plasma is much larger than the dimensions of the probe and the electric double layer, the probe practically does not disturb the plasma under study. In the continuous mode, when the opposite relationship between the dimensions of the
probe and the mean free path of particles in the plasma is fulfilled, the presence of the probe in the plasma produces a very significant local disturbance of the studied plasma. A double electric layer is formed around the probe, inside which the main parameters of the plasma, such as the concentration of charged particles, the electric potential, and the electric field strength, undergo significant changes in comparison with the parameters of the unperturbed quasi-neutral plasma. In this case, the theory of the probe must, first, adequately describe these changes in the basic parameters of the plasma, and, second, correctly describe the dependence of the currents to the probe on the plasma parameters.

There are several mathematical models for the operation of an electric probe under various conditions [9, 14, 15]. The method of electric probes was developed mainly for stationary plasma [9, 16, 17], and then extended to the conditions that are created behind reflected shock waves [18, 19]. The total current recorded by the electric probe consists of the conduction currents of positively charged ions, negatively charged free electrons (in the absence of negative ions), and the displacement current:

\[ I = S e (j_i - j_e) - \frac{S}{4\pi e} \frac{\partial^2 \varphi}{\partial t \partial r} \]

where \( I \) is the total current, \( S \) is the electric probe surface area, \( e \) is the electron charge, \( j_i \) and \( j_e \) are the density of conduction currents of positive ions and free electrons, \( \varphi \) is the electric potential for a particular time and at a given point in space, \( t \) is time and \( r \) is the distance from the axis of a cylindrical probe in cylindrical coordinates. The last term in this relationship is the displacement current which is caused by the non-stationary process of formation of a double electric layer near the probe surface.

The behavior of an electric probe under conditions of a nonstationary dense collisional quiescent plasma with chemical reactions of ionization, charge exchange, and recombination, which occurs behind reflected shock waves during the oxidation of various hydrocarbons, was investigated within the framework of a mathematical model constructed using the equations of plasma magnetohydrodynamics. Our analysis of the mathematical model of the operation of a cylindrical probe under conditions realized behind reflected shock waves showed that the rate of appearance of free electrons and primary positive ions \( W(t) \) is the main parameter that changes in time and affects the total current [19]. The results of numerical simulations show that the electric current passing through the electric circuit of the probe under given conditions depends mainly on \( W(t) \), while a change in the recombination coefficient in a relatively wide range of its values has only an insignificant effect on the current. The total net current is almost proportional to the rate of formation of positive ions in the gas phase.

![Figure 1](image-url)

Figure 1. Figure 1a shows an example of simulation of the concentration distributions of ions (solid lines) and (dashed lines) for the case of chemical ionization in a mixture of 0.5% CH₄ +
2.5% O₂ + 97.0% Ar at electrons \( T_5 = 2750 \text{ K}, p_5 = 1 \text{ bar} \) at different times from the beginning of the process: 1 - 10 μs, 2 - 14.4 μs, 3 - 20.2 μs. Probe potential \( \varphi_p = -9 \text{ V} \). Figure 1b shows the dependence of the calculated total current \( I_p(t) \) for a probe with a conducting surface on the current value of the ion production rate \( W(t) \) for different values of the probe potential: (1) \( \varphi_p = -9 \text{ V}; \) (2) \( \varphi_p = -48 \text{ V}; \) (3) \( \varphi_p = -72 \text{ V}. \) Arrows on the curves indicate the direction of the passage of time.

Thus, from the analysis of the results of our numerical simulation, an analytical approximation expression can be obtained that relates the ionization rate and the total electric current for a particular electric potential applied to a cylindrical probe of a certain size. From this dependence, from the experimentally measured profile of the total electric current to the probe, it is possible to obtain the chemical ionization rate \( W(t) \). Then it is possible to obtain the time dependence of the concentration of free electrons in the quasi-neutral region of the studied plasma. The concentrations of positive ions and free electrons in the quasi-neutral zone of the studied plasma are described by the following nonlinear equation:

\[
\frac{dn_e(t)}{dt} = W^{(0)}(t) - \alpha_0 n_e^2(t)
\]

This equation can be easily integrated numerically for a given ionization rate as a function of time \( W^{(0)}(t) \) and a given dissociative recombination coefficient \( \alpha_0 \), and as a result, the time dependence of the concentration of free electrons \( n_e(t) \) can be obtained.

4. Results and discussion

Let us consider the typical results of experiments on measuring probe currents and chemiluminescent radiation in a mixture of acetylene with oxygen obtained for different temperatures behind the front of the reflected shock wave.
Figure 2. Experimentally measured profiles of (1) pressure, (2) intensity of chemiluminescent 
 radiation of OH* radicals, (3) total current and (4) displacement current for the case of acetylene 
oxidation (mixture of 0.5% C₂H₂ + 2.5% O₂ + 97.0% Ar) for four different temperatures behind the 
front of the reflected shock wave: (a) T₅₀ = 1862 K; P₅₀ = 1.3 bar; (b) T₅₀ = 2080 K; P₅₀ = 1.45 bar; 
(c) T₅₀ = 2229 K; P₅₀ = 1.4 bar; (d) T₅₀ = 2575 K; P₅₀ = 2.13 bar. Electric probes with both insulated (4) 
and conductive surfaces (3) were supplied with a constant electric potential of φ₀ = -9 V. T₅₀ 
and P₅₀ designate the temperature and pressure values just behind the front of the reflected shock wave.

Figure 2 clearly shows that the maximums of the total current to the conducting probe and the 
displacement current to the probe with a dielectric surface practically coincide and are very close to 
the maximum of chemiluminescent radiation. With an increase in temperature, the total current to the 
conducting probe at long times begins to show an irregular character of change with time. In this case, 
the displacement current recorded by the probe with a dielectric surface demonstrates only the first 
maximum associated with the chemical ionization process and is completely free from any irregular 
changes. Mixtures of methane with oxygen exhibit a similar behavior.

Figure 3 shows the results of similar experiments for a mixture of methane with oxygen and the 
results of their processing according to our proposed method. As can be seen from Fig. 3, the time 
dependence of the concentration of free electrons, determined from the processing of the total current 
to the conducting probe, is close to the dependence obtained from our detailed kinetic simulations.

Figure 3a shows the experimentally measured profiles of (1) pressure, (2) intensity of chemiluminescent 
radiation of OH* radicals, (3) total current and (4) displacement current for the case of methane oxidation 
(mixture 0.75% CH₄ + 3.0% O₂ + 96.25% Ar) for temperature T₅₀ = 2613 K and
pressure $P_{50} = 1.78$ bar behind the reflected shock wave. Electric probes with both (4) insulated and (3) conducting surfaces were supplied with a constant electric potential of $\Phi_p = -9$ V. Figure 3b shows the time dependences of the concentration of free electrons obtained from the processing of the total currents to the probe with a conducting surface and from our detailed kinetic simulations. $T_{50}$ and $P_{50}$ designate the temperature and pressure values just behind the front of the reflected shock wave.

The ultimate goal of any electric probe measurements, as well as measurements by any other method, for example, by the method of microwave diagnostics, is to determine the parameters of the investigated medium containing charged particles. To solve this problem, it is necessary to construct a mathematical model of the operation of an electric probe under conditions of a dense quiescent low-temperature plasma with chemical reactions, including reactions of chemical ionization, charge exchange, and dissociative recombination. Such a mathematical model was developed by us earlier on the basis of the equations of magnetohydrodynamics [15, 19].

Earlier, we experimentally and theoretically showed that in experiments on a shock tube, the main kinetic parameter affecting the probe current is the ionization rate, i.e., the number of ions and free electrons appearing in the gas phase per unit time. For the total current to an electrically conducting cylindrical probe, based on the analysis of a large number of numerical simulations, an analytical approximation dependence was obtained, which related the value of the probe current (the total current) and the ionization rate, as well as quantities such as the potential of the probe and the surface area of the probe for given values of the mobility and diffusion coefficients [15, 18–20].

Now we are faced with the task of performing a similar procedure for displacement currents to an electrically insulated probe. Since, as experiments show, the displacement currents differ in shape from the total currents (the displacement currents are noticeably narrower), then in order to obtain the electron concentration from the displacement current, which coincides with the electron concentration obtained from the total current, the analytical approximation dependence for the displacement current should be other, different from such a dependence obtained by us earlier for the total current. The formulation of the mathematical model of the operation of the probe under our conditions and the obtained preliminary results of calculations for finding the total currents and displacement currents for a conducting probe and displacement currents for an isolated probe are presented in [21].

Currently, work in this direction continues, and we hope to get positive results. Then the displacement currents can be used to find not only qualitative, but also quantitative kinetic information about the studied plasma.

5. Conclusions
Our experiments on the measurement of chemical ionization during pyrolysis and oxidation of various mixtures of acetylene and methane with oxygen, diluted with argon, show that the displacement currents recorded by electric probes at negative potentials for conditions occurring behind reflected shock waves are influenced by surface ionization processes of various impurities. The isolated surface of the probe is influenced by surface ionization processes to a much lesser extent than the total currents measured on probes with a conductive surface. A pronounced correlation is observed between the maximum of the displacement currents on an isolated electrical probe at a negative potential and the maximum intensity of the chemiluminescent radiation of OH* radicals. The results of our experiments show that the process of chemical ionization proceeds intensively only in the presence of oxygen in the reaction mixture.

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