The results of measurements indicate that the Néel temperature of chromium decreases with increase in pressure at the rate of 5.6°C per 1000 atm. Consequently, the exchange integral, which is proportional to the Néel temperature, also decreases with pressure. Hence, we may conclude that a reduction in the distance between atoms in chromium leads to a reduction in the absolute magnitude of the exchange interaction.

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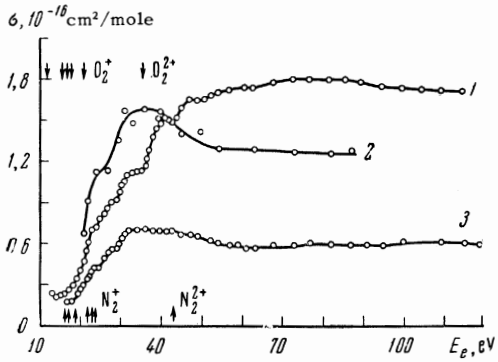

Dissociation cross sections for O_2^+ and N_2^+ ions in collision with molecules of air, as a function of electron energy: curve 1 – reaction (1); curve 2 – reaction (2); curve 3 – reaction (3). The cross section for reaction (2) has been multiplied by a factor of 100. The statistical error in the values of the cross sections for reactions (1) and (3) is in the vicinity of 5–10% over the whole electron energy region except near threshold; in the threshold region the error is of the order of 30%. The corresponding values for reaction (2) are roughly 15% and 30%. The arrows denote the positions of the known electronic states of O_2^+ ions ($^2\Pi_g$, $^4\Pi_u$, $^2\Pi_u$, $^4\Sigma_g^-$, Σ)[6] and N_2^+ ions ($X^2\Sigma_g^+$, $A^2\Pi_u$, $B^2\Sigma_u^+$, $^4\Sigma_u^+$, $^4\Delta_u$, $C^2\Sigma_u^+$)[7] and the potentials for production of doubly charged O_2^{2+} and N_2^{2+} ions.[8]

FORMATION OF EXCITED O_2^+ AND N_2^+ IONS IN IONIZATION OF AIR BY ELECTRONS

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IN connection with the physics of the upper atmosphere it is of interest to study the energy state of O_2^+ and N_2^+ ions formed in collisions of electrons with O_2 and N_2 molecules.

To obtain information on the energy state of the ions we utilized the dissociation, as the result of single collisions with molecules, of O_2^+ and N_2^+ ions accelerated to 2.8 keV, since the probabilities of these dissociation processes depend on the energy of the electrons.[1,2] The experiments of Tikhomirov et al with nitrogen[1] and those of McGowan and Kerwin with oxygen[2] were done with equipment not designed for obtaining values of the dissociation cross section of the ions. The dissociation cross section of N_2^+ ions has been determined by Fedorenko[3] in a double mass spectrometer in the ion energy region 5–25 keV. However, the effect of the energy state of the ions on the dissociation cross section was not studied in this case. The maximum electron energy used by McGowan and Kerwin[2] was below the potential for production of doubly charged O_2^{2+} ions, but highly excited O_2^+ ions could be formed in the energy region used. Highly excited atomic ions have been studied by Kupriyanov,[4] but there are no data for molecular ions.

In the present communication we report the main results of a study, made with a double mass spectrometer,[5] of the effect of electron energy on the dissociation cross section for the following processes [1]:

$$O_2^+ + M \rightarrow O^+ + [O + M]^*, \quad (1)$$

$$O_2^+ + M \rightarrow O^- + [O + M], \quad (2)$$

$$N_2^+ + M \rightarrow N^+ + [N + M]. \quad (3)$$

From the curves given in the figure it can be seen that an increase in electron energy results in a sharp rise of the cross sections for reactions (1)–(3). This rise occurs in the electron energy region where the thresholds occur for the excited electronic states of O_2^+ and N_2^+ ions. Some of these states are known to be metastable. There is structure also at higher electron energies, which may be due to the appearance of ions in unknown electronic states with thresholds of about 23–25, 28–29, and 31–32 eV for O_2^+ ions and ~ 25 and 29 eV for N_2^+ ions, as well as to a change in the content of ions of known states in the beams. We were unable to obtain more distinct breaks in the curves,

since some of the electronic states of the ions overlap in energy the vibrational levels of the remaining states. Therefore the energy dependence of the dissociation cross sections of O_2^+ and N_2^+ ions is affected not only by their electronic excitation but also by the vibrational excitation. The latter is clearly shown in the dissociation of H_2^+ hydrogen ions [9] and D_2^+ deuterium ions.[6]

The structure shown by curve 1 in the figure agrees with the results of McGowan and Kerwin [2] in the energy region examined by these authors. The structure of curve 3 was not observed by Tikhomirov et al [1] because of the large energy intervals used in the measurements and the narrowness of the region examined (25—50 eV).

Returning to the figure, we see that at an electron energy near the potential for production of O_2^{2+} ions, there is a sharp increase in the cross section for reaction (1). It is reasonable to associate this change in cross section with the appearance in the beam of highly excited O_2^+ ions which in a collision can break up with a high probability into two O^+ ions, an event which is to be expected on the basis of the energy requirements of the different dissociation processes and the Massey criterion.[10]

The cross section for reaction (2) falls with the appearance in the beam of highly excited O_2^+ ions, as we would also expect.

The cross section for reaction (3) does not increase, and even drops with a change of electron energy in the region near the potential for production of N_2^+ ions, which can serve as an indication of the absence of an appreciable quantity of highly excited N_2^+ ions in the beam.

The dissociation cross section for O_2^+ ions is considerably greater than for N_2^+ ions (roughly 1.5 times for electron energies up to 36 eV and 2—3 times for higher energies), which is due to the different stabilities of these ions. These ratios and the behavior of the curves in the figure change somewhat as a function of the experimental conditions [2)]; however the structure of the curves remains.

[1)] The particles included in the brackets can have different states: positive and negative ions, excited and unexcited atoms and molecules. We have observed negative O^- ions corresponding to reaction (2) whose probability is a small fraction of that for reaction (1). We did not observe negative N^-.

[2)] Thus, for example, a decrease in the time from the formation of the ions in the source to their collision with the molecules in the chamber leads to some increase in the cross sections for reactions (1) and (3) and to their convergence. This compels us to assume that the excitation of O_2^+ ions is preserved for a longer time than that of N_2^+ ions.

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STUDY OF THE "SPARK" PRODUCED IN AIR BY FOCUSED LASER RADIATION

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IN focusing radiation from a laser with modulated Q, beginning at some critical value of peak power, a phenomenon is observed in air which is similar to electrical breakdown in gases.[1,2] At the focus of the lens a bright luminous spark occurs, accompanied by a characteristic sharp clap very reminiscent of an ordinary electrical spark. In this letter we report some results of an experimental study of this "spark" in air.

To obtain a high power pulse we used a ruby laser with pulse modulation, described by Gvaladze et al.[3] The pulse has an approximately triangular shape with a half-width $\tau \sim 40$—50 nsec and a peak power up to 30 MW. The diameter of the beam is ~ 12 mm and the angular divergence φ is ~ 3—$5'$.