Proceedings of the
XV International Conference on

PHENOMENA IN IONIZED GASES

1981

Contributed Papers
Part I

Minsk, July 14-18, 1981

USSR

DISCHARGE PLASMA KINETICAL COEFFICIENTS CALCULATIONS FOR MIXTURES OF VIBRATIONALLY EXCITED CO_2 WITH INERT GASES

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Discharge plasma in mixtures of inert and molecular gases is widely used for vibrational excitation of molecules. Interesting suggestions for using strongly nonequilibrium mixtures of CO_2 with inert gases based on preferable excitation of symmetrical and bending modes in discharge were done in /1,2/. Below results are presented of kinetical coefficients calculations executed by numerical solution for Boltzman equation taking in consideration vibrational excitation of CO_2 molecules in mixture with inert gases. This equation is well known /3/ and not presented here.

Next information on electron collisions cross sections was used. Transport, electron level excitation and ionization cross sections were taken from /4/. Resonance rotation excitation for two- and fourquantum transitions in CO_2 were used from /5/. Rotational excitation energy losses were written in diffusion approximation. For electron energy above 3 eV resonance excitation of symmetrical and bending modes was taken in consideration both from the ground and other below lieing energy level for symmetrical mode quantum number change $\Delta V_i \leq 8$ and vibrational angular moment $\Delta l \leq 1$. Cross sections for sequential transitions without angular moment changing were taken from /6/. In the case $\Delta l = 1$ cross sections energy profiles were conserved, values in dependence on ΔV_i were admitted in accordance with /7/. For electron energy below 3 eV infrared active modes excitation is determined by electron interaction with transition dipole moment of CO_2 molecules. Excitation of symmetrical mode in the same energy area is determined by polarisation interaction /8/. Cross sections for the first levels of modes were compiled from /9/. Sequential transitions cross sections were admitted in accordance with harmonical oscillator matrix elements. So considering energy level population distribution to be Boltzman with vibrational temperature T_v, it is possible to sum for sequential transitions in kinetical equation. As a result effective mode excitation cross sections from the ground level and according deexcitation cross sections may be used in kinetical equation. Deexcitation cross sections were determined using detailed balance principle.

Enumerated cross sections were used for computer calculation of electron energy distribution function. Second order differential kinetical equation was replaced by net difference equation. Obtained linear system was numerically solved by optimal exclusion method /10/. In the all far given results vibrational temperatures

for three modes were admitted the same. The next discharge parameters were calculated: electron drift velocity, rate constants for different processes and relative parts of energy flow transferred from electrons to molecules in these processes, transverse D and longitudinal D_L diffusion coefficients. Longitudinal diffusion coefficient was calculated using formulas from the book /11/. D/μ and D_L/μ dependence on E/N for helium, D/μ for CO_2 at T=300K, T_v=300 and 2000K are shown in fig.1 (μ is electron mobility). The first three curves agree well with experimental data given in the book /11/.

Drift velocity, D/μ and D_L/μ dependence on E/N for mixture CO_2:He=1:9 at T_v=0 and 2000K are shown in fig.2. Vibrational excitation slightly influences on drift velocity. Electron energy balance for the same mixture is shown in fig.3. In selfsustained discharge E/N parameter area vibrational excitation has relatively small influence on electron energy balance. When E/N parameter is so small that may be realised only in nonselfsustained discharge the energy flow into symmetrical and bending modes dominates in vibrationally cold gas mixture. As s result of vibrational levels excitation energy flow into asymmetrical mode sharply increases.

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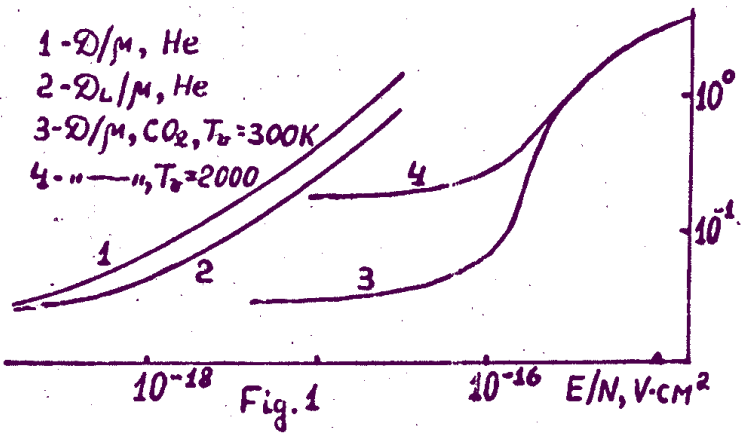

Fig.1

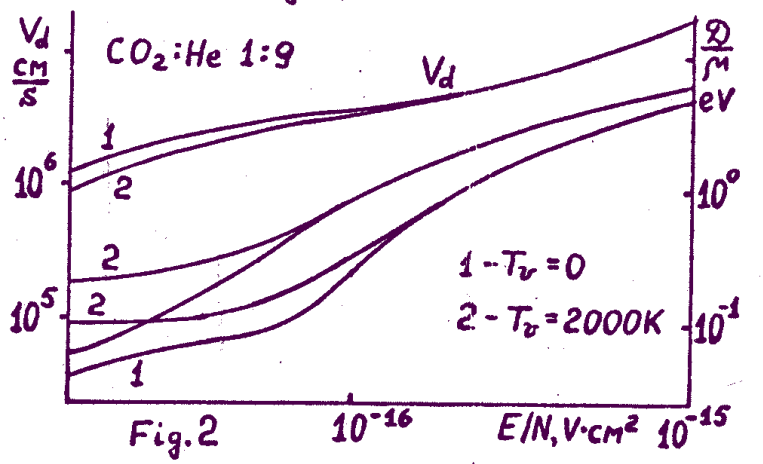

Fig.2

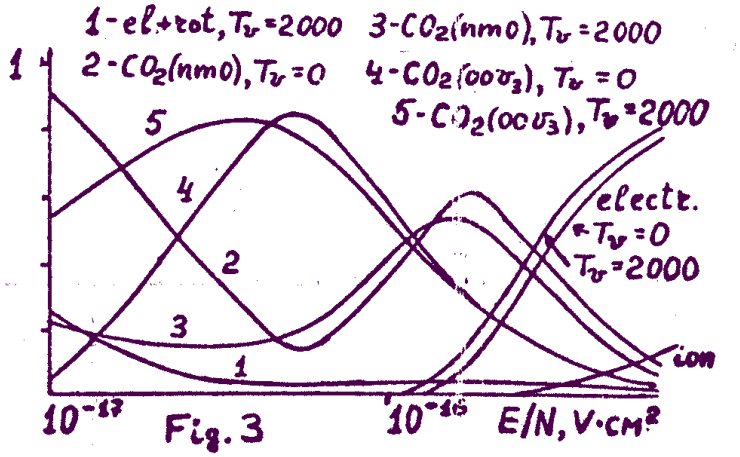

Fig.3