

Creation of non-stationary volume discharge inside cylindrical microwave resonator

Long Che

Nanjing University of Sci. & Tech
No.200,Xiaolingwei street,Xuanwu
District, Nanjing, Jiangsu Provinc
Nanjing, China
564799167@qq.com

Hongda Li

Shenyang Ligong University
No.6,Nanping Middle Road, Hunnan
New Distict, Shenyang, Liaoning Provinc,
China
Shenyang, China
308544490@qq.com

Sergei Sosnovskiy

Tomsk state university
Ministry of Science and Higher
Education of the Russian Federation
36 Lenin Ave., 634050,
Tomsk, Russia
ssa777@mail.ru

Alexander Lukanin

*Tomsk state university of architecture
and building*
*Ministry of Science and Higher
Education of the Russian Federation*
2, Salt Sq., 634003,
Tomsk, Russia
loukanin@list.ru

Alexander Tskhe

Tomsk state university of architecture and
building
Ministry of Science and Higher Education
of the Russian Federation
2, Salt Sq., 634003, Tomsk,
Russia
pkbtb23@mail.ru

Anna Tskhe

Tomsk polytechnic university
Ministry of Science and Higher
Education of the Russian Federation
30 Lenin Ave., 634050, Tomsk,
Russia
anny0393@mail.ru

Relevance

The need for thermal treatment in various industries has prompted research and development of powerful, non-polluting, inexpensive and low-cost low-temperature plasma source.

Experimental setup microwave plasma torch in air

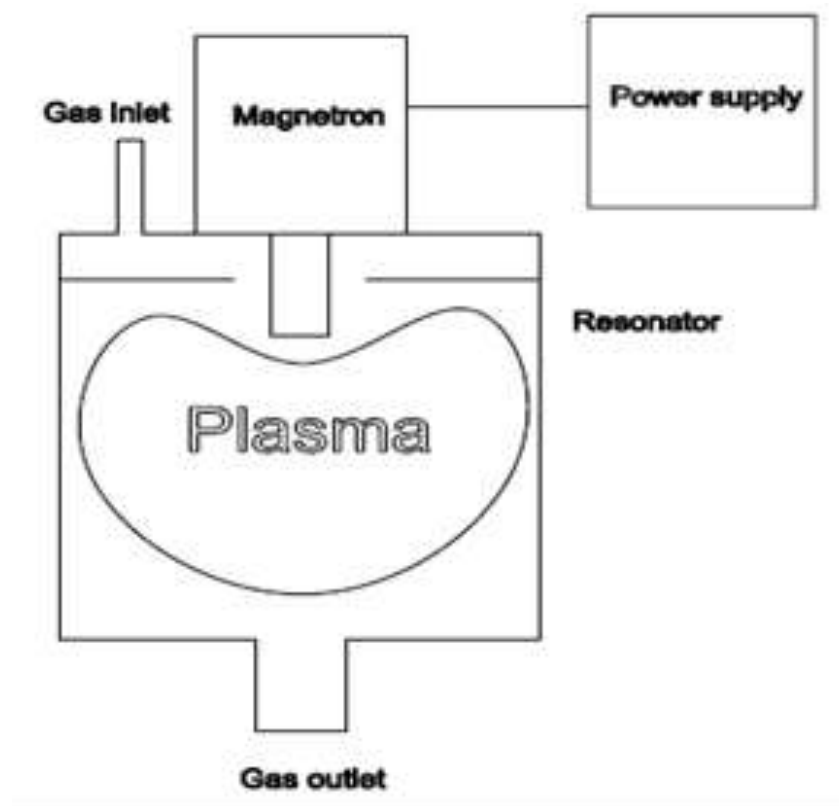


Fig. 1. Schematic diagram of experiment system

The results of a thermodynamic investigation of the O_2-N_2 system in the conditions of a plasma, using the TERRA software

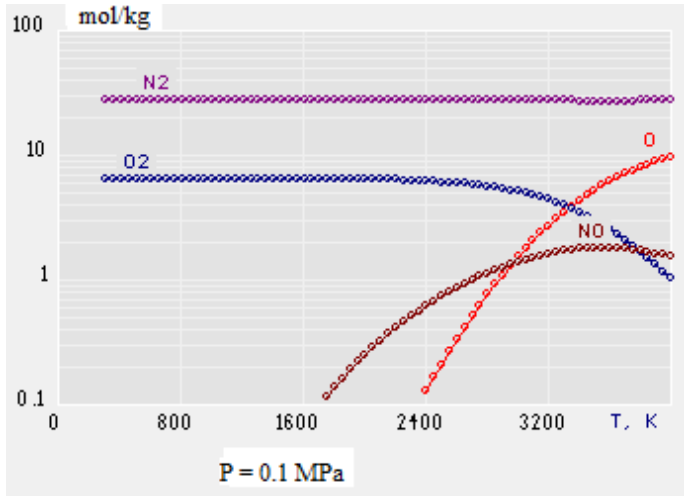


Fig.2. Phase composition in the $O_2 - N_2$ system under plasma conditions

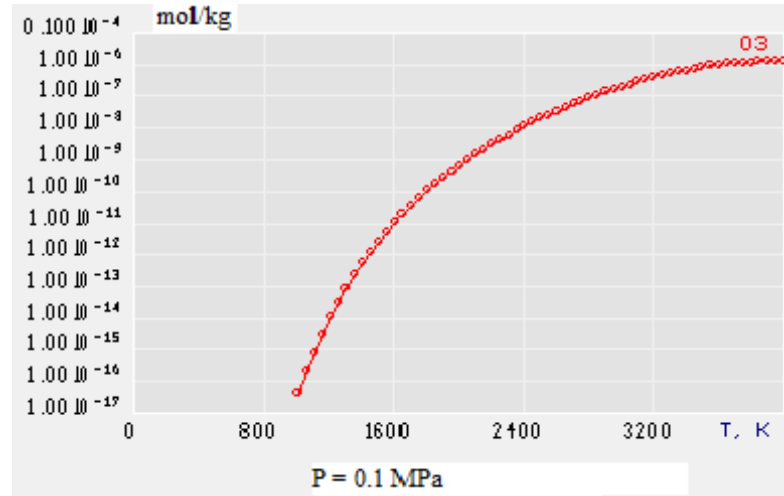
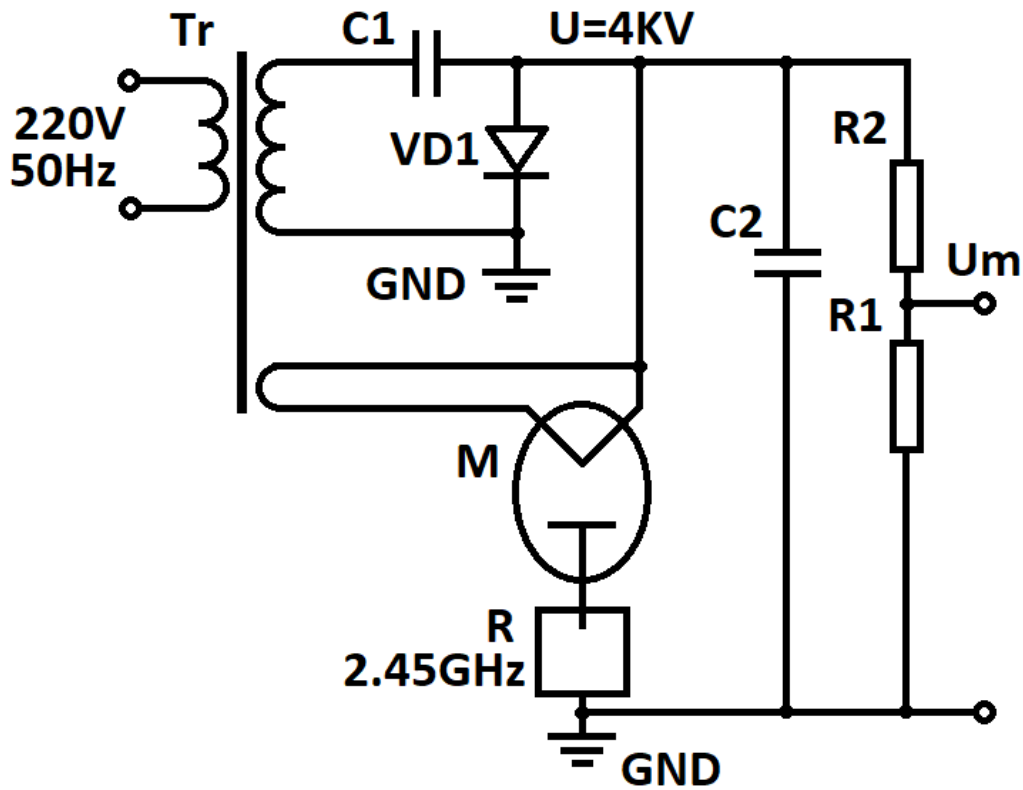


Fig.3. Phase composition in the $O_2 - N_2$ system under plasma conditions

- Phases N_2 in the temperature range 300 – 4000 K.
- Phases O_2 in the temperature range 300 – 4000 K.
- Phases O in the temperature range 2400 – 4000 K.
- Phases NO in the temperature range 1800 – 4000 K.
- Phases O_3 in the temperature range 1000 – 4000 K.
- The formation of ozone and atomic oxygen in the microwave plasma is thermodynamically probable.
- Atomic oxygen, as an active particle, subsequently leads to the formation of ozone. Nitric oxide is an active particle.



- Tr - serial power transformer
- Vd1 - rectifier diode (column)
- M - magnetron OM75S
- R - cylindrical resonator
- C1, C2 - capacitors
- Tr - power transformer
- Vd1 - voltage doubler
- R1, R2 - voltage divider
- M - magnetron
- R - quarter-wave resonator

Fig.4. Diagram of magnetron activation



Fig.5. Photo of the magnetron

Voltage divider R1, R2 (1:200) was used to measure the voltage on the magnetron, with a JDS3102A oscilloscope, 100 MHz, 1GSa/s. M - magnetron, 1 - gas inlet to the resonator

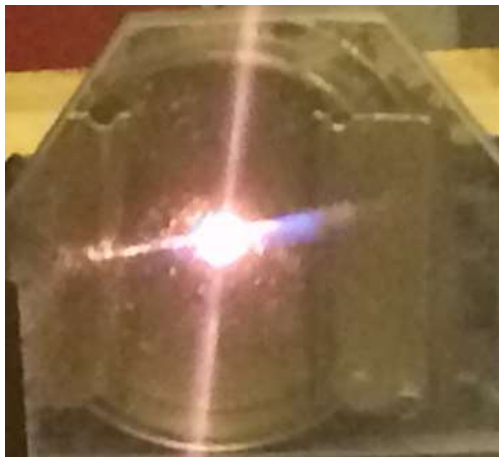


Fig.7. Discharge combustion in resonator

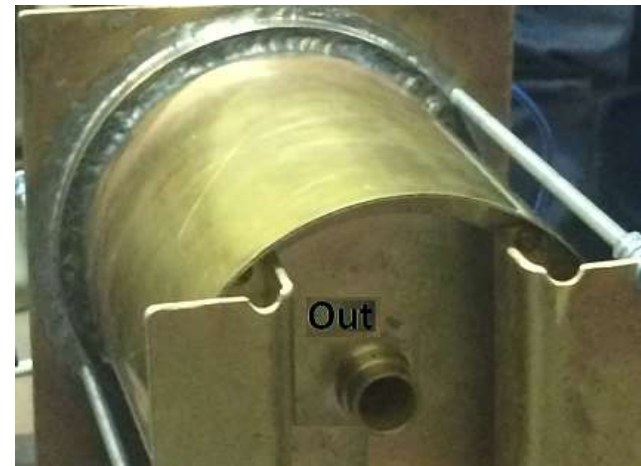


Fig.6. Resonator

The gas was supplied to the resonator from the side of the magnetron anode and coaxially to the anode, the ignition of the discharge (plasma) was controlled through the outlet nozzle. Out - gas output.



Fig.8. Experimental setup microwave plasma torch in air

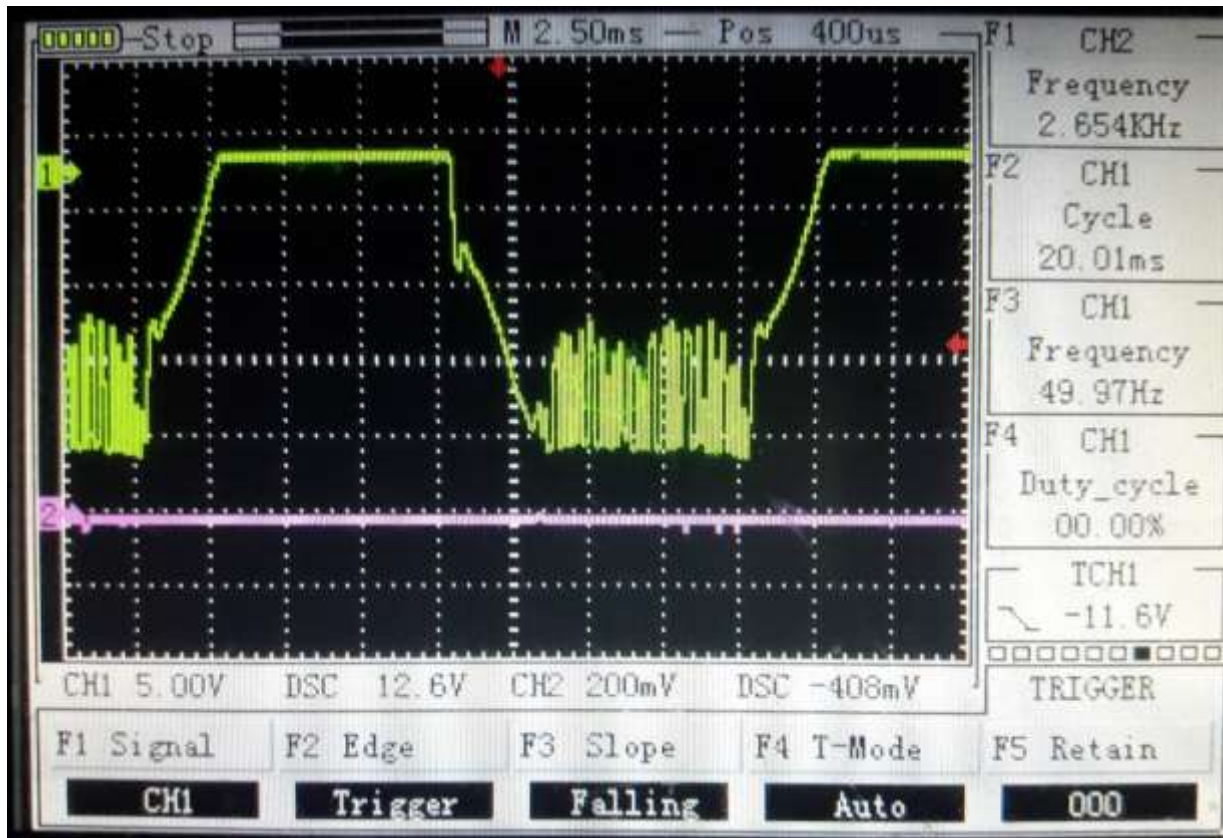
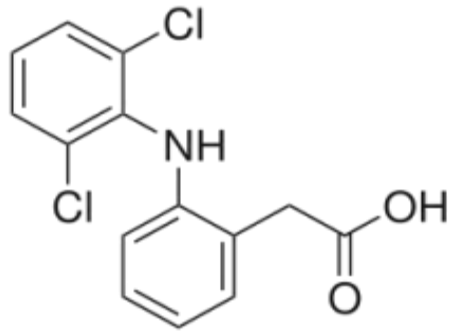


Fig.9. The voltage oscillogram from divider output

Destruction of molecular compounds



Diclofenac is a well-known anti-inflammatory drug that, being present in the wastewater of many industries, gets into natural waters and has a harmful effect on the ecosystem.

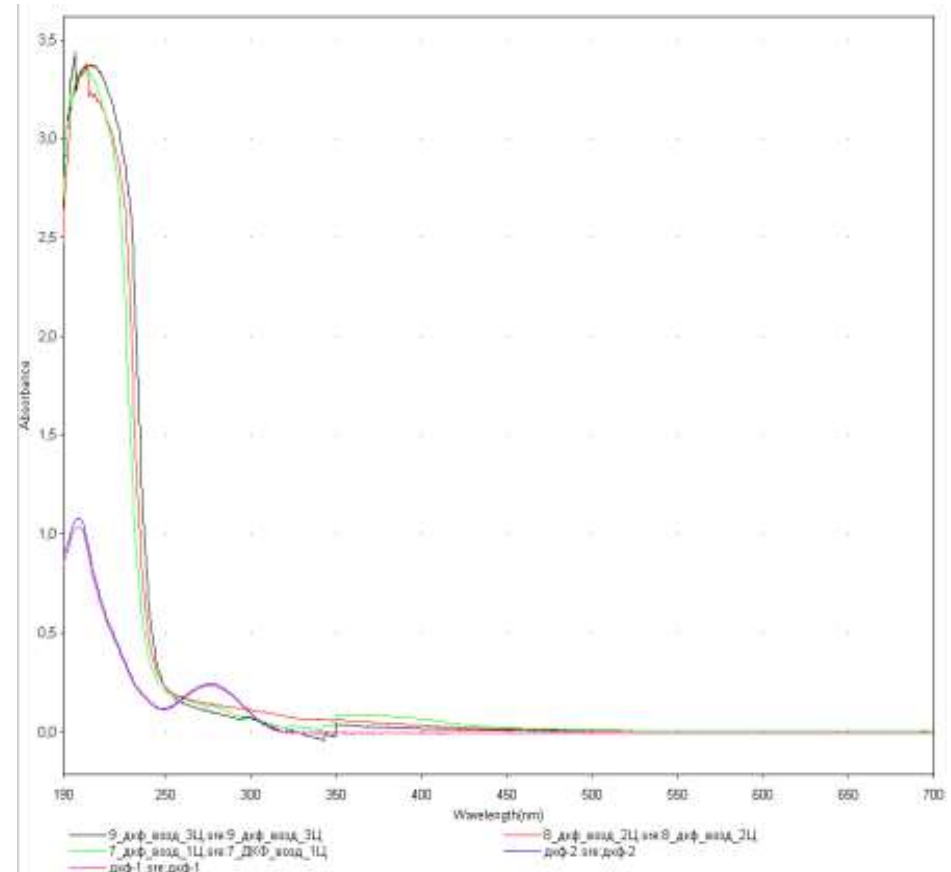


Fig.9. Absorption spectrum, carrier gas air

	Air				CO ₂			Ar		
	Исх.	1 cycle	2 cycles	3 cycles	1cycle	2 cycles	3 cycles	1 cycle	2 cycles	3 cycles
pH	5,6	2,86	2,68	2,45	6,15	5,6	5,42	4,45	6,41	3,39
PO	2,52	0,4	0,52	0,44	2,71	1,86	2,3	1,03	0,99	1,54
NO ₂ ⁻	-	-	-	2,34	-	-	149,48	-	-	26,20

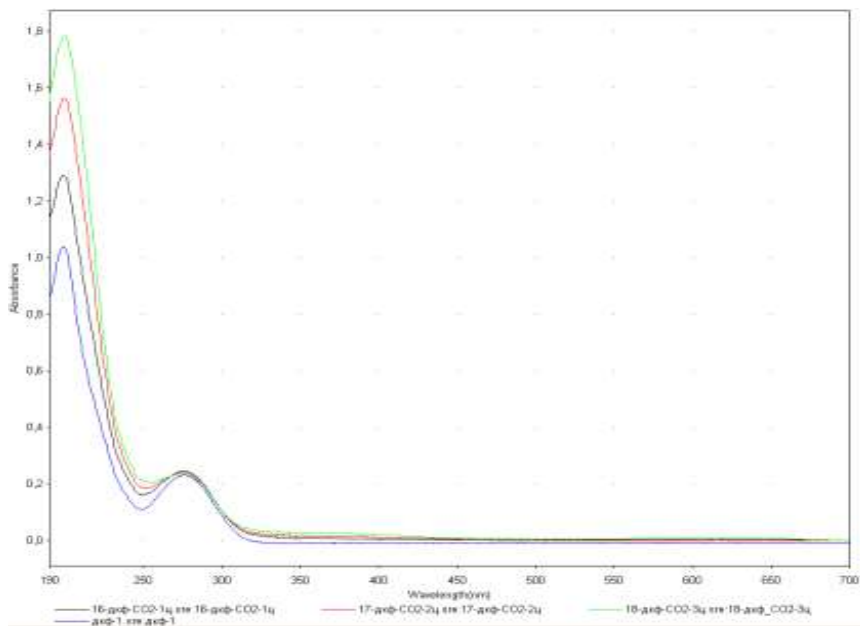


Fig.10. Absorption spectrum, carrier gas CO₂

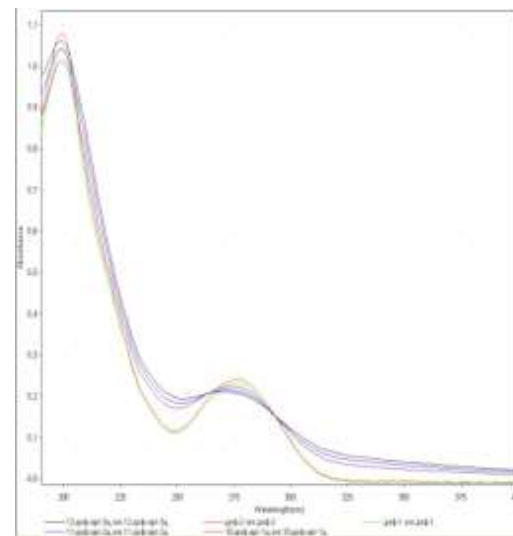


Fig.11. Absorption spectrum, carrier gas Ar

Methylene blue

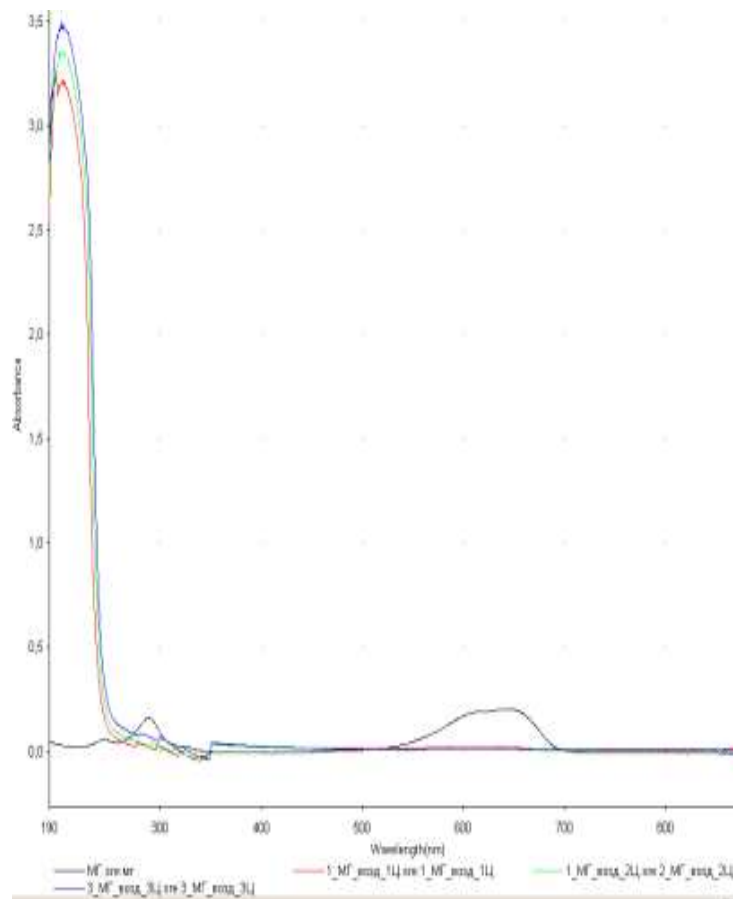
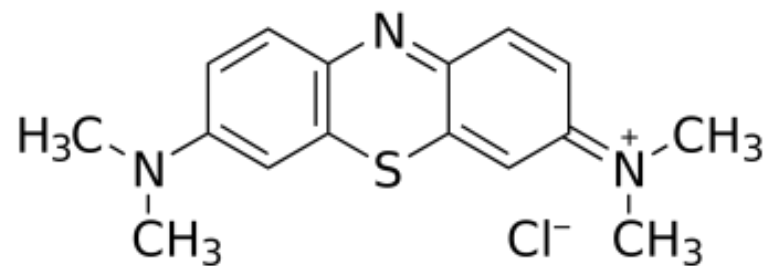


Fig.12. Absorption spectrum, carrier gas air

Conclusion

- An experimental microwave plasma system has been created.
- A high-voltage pulse generator was developed and launched.
- The study includes both experiment and simulation. The possibility of ozone formation is shown.
- A thermodynamic study of plasma chemical processes occurring in a microwave burner was conducted, which made it possible to determine the feasibility of forming certain amounts of chemical compounds under specified conditions.
- Thermodynamic analysis was performed in the universal TERRA program.
- The possibility of destruction of molecular compounds in microwave plasma is shown.

Thanks for your attention!