

proceedings of the fifth international conference on

# **CHALLENGES in HIGHER EDUCATION and RESEARCH in the 21st CENTURY**

organized by the Technical University of Sofia  
June 5-9, 2007, Sozopol, Bulgaria

eds. Nikolay Kolev, Lubomir Dimitrov



Heron Press · Sofia · 2007



**Heron Press · Sofia**  
**ISBN 978-954-580-227-0**

## CONTENTS

### SECTION 1: Higher Engineering Education

<i>R. Setchi</i> : Personalisation in Professional E-Learning and Performance Support . . . . .	11
<i>E. Gourova, A. Antonova, K. Nikolaos</i> : Differences in Knowledge Management Usage in Bulgaria and in Greece . . . . .	15
<i>E. Gourova, A. Antonova</i> : Factors for Success of Knowledge Management . . . . .	18
<i>M. Loukaycheva, A. Lirkov, B. Tzaneva</i> : Corrosion Control Cost Requires Corrosion Education . . . . .	23
<i>D.A. Luþsa-Tãtaru, S. Constantin</i> : Knowledge Management Maturity Level and Developments in Romanian Universities . . . . .	27
<i>A.I. Lazarov</i> : European Technical Directives in the Engineering Education . . . . .	30
<i>B. Bãcanu</i> : Managerial Education in Romania . . . . .	33
<i>L.A.-M. Bãdescu, M. Popescu, E. Helerea, O.A. Pirnuta</i> : Synthetic Indicators for the Assessment of the Intellectual Potential of Research . . . . .	37
<i>E. Gourova, A. Antonova, K. Nikolaos</i> : Differences in Knowledge Management Usage in Seven European Countries . . . . .	40
<i>T. Dimitrova, T. Tashev, R. Deliyiski</i> : Knowledge Management in Software Competence of Engineering Students . . . . .	43
<i>D. Marguenova</i> Technical University of Sofia Erasmus Policy Statement in the Context of LLP /Erasmus Program (2007-2013) . . . . .	48

### SECTION 2: Information Technologies in Education

<i>M. Mohanea, G. Toganel</i> : The Basics of Pedestrian Mathematical Models Using Lagrange Multipliers and Solution Stabilization . . . . .	53
<i>P. Borovska, V. Zlatev, N. Landzhev</i> : Experimental Platform for Virtual Screening and Computer Simulation for Drug Design . . . . .	57
<i>P. Borovska, M. Lazarova</i> : Performance Evaluation of Solving the Parking Garage Problem in Parallel . . . . .	61
<i>P. Borovska, M. Lazarova</i> : Methodology for Parallel Application Development . . . . .	65
<i>P. Tzvetkov, G. Petrov, P. Iliev</i> : Instrumentation Periphery Modules for PC Based Platforms . . . . .	70
<i>T. Stoyanova</i> : Additional Compression of Compressed Files . . . . .	74
<i>P. Borovska, M. Lazarova, P. Adamovski</i> : Flat and Hybrid Parallel Programming Models for Solving Combinatorial Search Problem . . . . .	78
<i>G. Popov</i> : Investigation of Problem Eating Philosophers . . . . .	83
<i>G. Popov, G. Naydenov</i> : A TPN Model of Half Duplex Protocol in Wireless Security Systems . . . . .	85
<i>N. Gourov, N. Chalashkanov, G. Nikolov</i> : Virtual System for PD Investigation . . . . .	87
<i>O. Nakov, D. Petrova</i> : Graph Algorithm for Moving Object Tracking . . . . .	91
<i>M. Goranova, L. Milkov</i> : Investigation of the Productivity and Mutual Concurrency of Object Oriented Database Systems with Applications . . . . .	95
<i>V. Gancheva, B. Shishedjiev, J. Georgieva</i> : Security of Data in WEB Applications . . . . .	101
<i>V. Gancheva, B. Shishedjiev, J. Georgieva, V. Mladenov</i> : WEB Service for Data Validation in WEB Applications . . . . .	105

### SECTION 3: Design

<i>T.E. Bolfa</i> : Correlation between Influencing Factors and Working Conditions for High Speed Bearings . . . . .	111
<i>V. Dantchev, G. Hadjikossev</i> : Robotic End-Effectors in Semiconductor Industry . . . . .	114
<i>A. Olãrescu, M. Cionca, L.A.-M. Bãdescu, I. Muscu</i> : Designing and Manufacturing Furniture with Branch Wood Panels . . . . .	119
<i>G. Toganel, M. Mohanea</i> : The Influence of the Impact Speed and Vehicle Shape Variation on Parameters Such as HIC and AIS Regarding Vehicle-Pedestrian Accidents. Forming Relationships . . . . .	124
<i>N. Petkova, P. Nakov, V. Mladenov</i> : Diagnosis of Partial Discharges in Power Transformers . . . . .	132
<i>P. Cruciat, F.A. Sarbu</i> : Fits of the Assembling with Bearings . . . . .	135

## CONTENTS

<i>P. Cruciat, F.A. Sarbu</i> : Choosing the Tolerances for Cylinder Parts .....	139
<i>C. Biş</i> : On the Main Parameter Involved Within Fatigue Crack Propagation Laws .....	143
<i>C. Biş</i> : On a Generalized Fatigue Crack Propagation Law .....	146
<i>M. Ispas</i> : Analysis of Band Saw Blades by the Finite Element Method .....	148
<i>C. Gheorghe</i> : Multicriterial Optimisation of the Machine Tools Basic Components .....	152
<i>I. Neagoe, F. Dogaru</i> : The Simulation of Spinning by Finite Element Method .....	156
<i>L.A.-M. Badescu, M. Popescu, E. Helerea, O.A. Pirnuta</i> : Synthetic Indicators for the Assessment of the Intellectual Potential of Research .....	159
<i>S.M. Zaharia, G.-R. Buican, I. Martinescu</i> : A Study about Reliability Tests with Suspended Elements .....	161
<i>S.M. Zaharia, G.-R. Buican, I. Martinescu</i> : Analytical Determination of Reliability Using the General Equation of Reliability, Used in Probabilistic Design of Mechanical Systems .....	164
<i>J. Angelova</i> : Requirements of Electrical Power Engineering Improvement on the Basis of Theoretical Analysis .....	169
<i>D.R. López, G. Todorov</i> : Resource of Influence of Different Parameters in Plastic Injection .....	174
<i>J.M. Garcia, I. Ianakiev, V.D. Slavov</i> : Kinematics and Dynamics Simulation in a 3D Model of a Real Robot BOSCH SR60 .....	179
<i>L. Dimitrov, E. Manolov, G. Hadjikosev</i> : Determination of Crack Initiation Angle on Spur Gear Teeth .....	187
<i>A.D. Sánchez, I. Ianakiev</i> : Design, 3D Model and FEA/FEM Experiments of the Housing of an Impact Drill .....	190
<i>M. Ispas</i> : Unconventional Design for the Cutting Mechanism of the Vertical Frame Saws .....	196

### SECTION 4: Manufacturing

<i>B. Lepadatescu, E.-A. Dumitrascu, I. Enescu</i> : Increasing the Machining Capacity in Superfinishing with Abrasive Stones .....	201
<i>B. Lepadatescu, C. Buzatu, I. Enescu</i> : Establishing of the Trajectory Equations of an Abrasive Grit in Superfinish Process .....	204
<i>L.S. Vassileva, S.V. Vasseva, R.L. Huston, B.P. Bardes</i> : Types of Time-Temperature-Transformation Diagrams for Various Matrix Microstructures of Unalloyed Ductile Irons .....	206
<i>Gh. Boncoi, M. Barbu, M. Alexandrescu</i> : Production System – Large-Scale Dynamic System Hierarchically Organized .....	213
<i>Gh. Boncoi, M. Barbu, M. Alexandrescu</i> : Analysis of the Production System Viewed as Large-Scale Dynamic System .....	217
<i>Gh. Boncoi, M. Barbu, M. Alexandrescu</i> : Analysis of the Production System Viewed as Large-Scale Dynamic System .....	222
<i>A. Olărescu</i> : Software for Dimensioning Panels Made of Branch Wood for Furniture Manufacturers .....	227
<i>G. Takov, B. Makedonski, E. Sandulova</i> : The Abrasive Disks from Ruby Electro-Corundum – an Optimum for Grinding of High-Speed Steels .....	231
<i>A. Fota</i> : Control System Architecture for a Flexible Manufacturing System .....	234
<i>A. Fota</i> : The Flexible Manufacturing System, the Basic Component to the Implementation a Computer-Integrated Manufacturing .....	237
<i>R.E. Mellin, R. Setchi</i> : Mass Customisation in the Automotive Industry .....	240
<i>R. Georgieva, N. Andreeva</i> : Inventory Management Modeling for Coca-Cola Hellenic Bottling Company, Bulgaria .....	245
<i>D. Paskaleva, R. Georgiev, S. Angleova, L. Klochkov</i> : Opportunities for the Automation of the Production Processes of Mattresses in “HEGRA D” Ltd. ....	249

### SECTION 5: Measurement and Control

<i>G.I. Popov</i> : A Watchdog Subsystem Model with Timed Petri Nets .....	259
<i>V. Karlova, S. Enev, K. Kostov</i> : Application of Some Complex Transfer Function Isoparametric Trajectories .....	261
<i>R. Tzeneva, A. Radev</i> : Visualization of Lorentz Force Vectors in Vacuum Chamber under Test .....	265
<i>P. Dineff, D. Gospodinova</i> : Characteristics and Behaviors of Magnetron Dielectric Barrier Discharge .....	269
<i>P. Dineff, D. Gospodinova</i> : Characteristics and Behaviors of Dielectric Barrier Discharge at Changing Air Pressure .....	273

## CONTENTS

<i>S. Yordanova, B. Tabakova: Single Input Fuzzy Control of Indoor House Temperature</i> .....	277
<i>J.R. Galdeano, V.D. Slavov: 5-Channels Virtual Temperature Measurement and Control System</i> .....	282
<i>E.M. Miral, V. Bogeov: Quality Control in "Bulgarian Silk Ltd"</i> .....	288
<i>M. Ionescu: The Propagation Time</i> .....	294
<i>M. Ionescu: Stepper</i> .....	296
<i>N.G. Nikolova, E.K. Nikolov: Analysis and Development of Repetitive Robust Control Systems</i> .....	298
<i>S. Ivanov: Investigating the Clarification of Kaolin Suspension by Plotting the Sedimentation Curve during Electric Coagulation</i> .....	303
 <b>SECTION 6: Measurement and Control !!!novo</b>	
<i>M. Kroumova: Benchmarking as Management Approach and Method in the Conditions of Globalisation of the Economy</i> .....	309
<i>L. Gaceu, I. Gaceu: The 5S – A Successfully Method for Continuous Improvement of Quality in Engineering</i> .....	313
<i>S. Constantin, D.A. Lupşa-Tătaru: Approaches to Long-Range Planning for Small Business</i> .....	316
<i>R.-G. Albu, S. Constantin: Importance of Tourism Planning for Sustainable Development Management at Regional Level</i> .....	319
<i>S.S. Duicu: Aspects Regarding European Policy in Dangerous Chemical Substances Chain</i> .....	322
<i>S.S. Duicu: Testing Methods Used for Dangerous Chemical Substances Data Base</i> .....	324
<i>A.I. Lazarov: GSM and Human Health</i> .....	326
<i>F.P. Cezar: Economic Globalization, Determining Factor in Technical and Economic Reorganization of Business Companies</i> .....	329
<i>F.P. Cezar: Measuring Globalization</i> .....	332
<i>I. Nikolova: Measuring Quality in Public Administration</i> .....	334
<i>G. Ialomiţianu: Accounting Role in Economical Decisions' Fundament</i> .....	339
<i>O. Şaramet, A. Bianov: Warranty Measures Referring to the Right of Information</i> .....	340
<i>A. Aldea: The Charge with a Criminal Offence against a Person in the Jurisprudence of the E.C.H.R.</i> .....	343
<i>C. Gheorghe: Contributions Regarding the Determination of Environment Cost</i> .....	346
<i>D. Ardeleanu, A. Nedelcu: Occupational Health and Safety Management Systems' Audit at an Organizational Level</i> .....	349
<i>D. Ardeleanu, A. Nedelcu: Maximum Safety Management in an Industrial Organization</i> .....	353
<i>D. Soca: The Prediction of Demand, Key Element of Marketing Research in Services</i> .....	356
<i>C. Constantin: The Role of Customer Relationship Management in the Marketing of Business Services</i> .....	360
<i>C.-G. Matei, O. Şaramet: Protocol No.14 to the Convention for the Protection of Human Rights and Fundamental Freedoms, Amending the Control System of Convention</i> .....	364
<i>O. Şaramet, A. Bianov: Warranty Measures Referring to the Right of Information</i> .....	367
<i>G. Ialomiţianu: Some Considerations Regarding the Administration of Budgetary Incomes Evolution's Process in Romania</i> .....	370
<i>E. Băcanu, B. Băcanu: Corporate Social Responsibility and SME</i> .....	372
<b>List of Contributors</b> .....	375

# CHARACTERISTICS AND BEHAVIORS OF MAGNETRON DIELECTRIC BARRIER DISCHARGE

P. Dineff, D. Gospodinova

Technical University of Sofia, Faculty of Electrical Engineering, 8 Kliment Ohridski, 1000 Sofia, Bulgaria

**Abstract:** In the present work, the behavior and parameters of a magnetron dielectric barrier air discharge are considered for industrial frequency and a pressure variation, which includes the entire working range of pressures for the existence of the discharge at room temperature – from the atmospheric pressure to the medium vacuum region. The magnetron dielectric barrier discharge is examined by means of the external static characteristic representing the average value of the current vs. the effective value of the voltage applied to the electrode system. The two characteristic areas of using the discharge – the area of ozone-and-oxygen-containing cold plasma and the area of plasma which contains nitrogen oxides  $\text{NO}_x$  – are determined. The electrical characteristics and parameters, characterizing the area of ozone-and-oxygen-containing cold plasma, are analyzed.

**Keywords:** cold discharge plasma, magnetron effect, magnetron dielectric barrier discharge, permanent magnet, vacuum and atmospheric discharges, volt-ampere characteristic method, voltage of burning

## Introduction

The most well-known discharge type with crossed magnetic and electric fields is the *magnetron discharge* at atmospheric pressure (vacuum). The electrons circulate in helices around the magnetic field lines and give rise to more ionization. The magnetron discharge is considered a variety of DC normal or abnormal glow discharges.

The magnetron effect is applied to a *dielectric barrier discharge* (DBD) by building a plasma generator with permanent strontium magnets and ferromagnetic electrodes forming an open magnetic system, which ensures the burning of the magnetron dielectric barrier discharge at crossed magnetic and electric fields, Figure 1, [3].

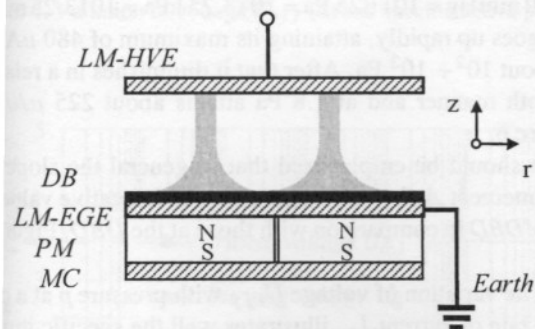


Figure 1. Volume MDBD plasma reactor: LM-HVE and LM-EGE – laminated magnetic high voltage and earth grounding flat planar electrodes; DB – dielectric barrier; PM – permanent magnets; MC – magnetic core.

Upon applying AC voltage to the electrode system with the top electrode covered by a dielectric glass barrier, a *MDBD* appears in the air gap.

Such non-thermal (cold) discharges are suitable for a wide range of applications, e. g. ozone generation, surface treatment and modification of plastic foils, textiles

and even metals, pollution control, sterilisation, ultraviolet and vacuum ultraviolet light sources for pumping of laser, AC plasma displays, etc., [1].

The task of the present work consists in studying and comparing the behavior and characteristics of *MDBD* at atmospheric pressure and at decreased pressure (vacuum) by using the method of external or static volt-ampere characteristic according to [2,3].

## 2. Experimental Investigation

The electrical behavior of an *MDBD* volume plasma generator with two co-planar plate electrodes is investigated. The size of the discharge gap is 6 mm. One of the two electrodes is covered by a dielectric glass barrier with thickness of 3 mm, Figure 1.

Volt-ampere characteristics of *MDBD* at various pressures are plotted with the help of the electrical circuit shown in Figure 2.

The critical parameters are calculated after linearization of the characteristic, whereupon the two characteristic regimes of *MDBD* – *RS* and *ST* – are differentiated, Figure 2.

The critical parameters characterize the ignition of *MDBD* for each of the two operating plasma areas – for *RS*: burning voltage  $U_{g,1}$ ; critical voltage and critical current  $U_{cr,1}$ ,  $I_{cr,1}$ ; for *ST*: burning voltage  $U_{g,2}$ ; critical voltage and critical current  $U_{cr,2}$ ,  $I_{cr,2}$ , Fig. 2.

In addition to these, the parameters characterizing the discharge burning are calculated, too – for *RS*: the current increase rate (or slope)  $B_2$  and intercept  $A_2$ ; for *ST*: the current increase rate (or slope)  $B_3$  and intercept  $A_3$ , Figure 2, [2].

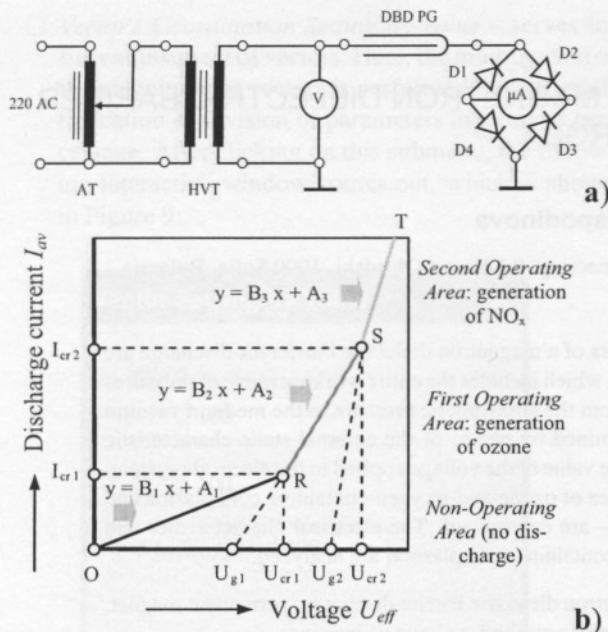


Figure 2. Electric circuit of an *MDBD* plasma generator (a) and polygonal linear model of a volt-ampere characteristic with two operating plasma areas – *RS*: ozone and oxygen plasma; *ST* –  $\text{NO}_x$  plasma (b). *AT* – transformer for voltage regulation; *HVT* – step-up transformer; *D1*, *D2*, *D3*, and *D4* – diodes allowing direct measurement of the average value of discharge current  $I_{av}$ .

### 3. Results and Discussions

Volt-ampere characteristics are plotted experimentally, after which the results are processed in accordance with the calculation methodology created, [2], and the results obtained are shown further below for the first operating area of an *MDBD* plasma generator.

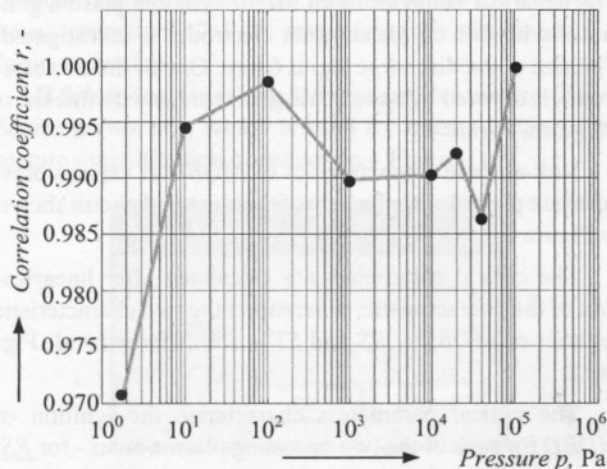


Figure 3. Variation of the coefficient of linear correlation  $r$  with pressure  $p$  for the operating plasma area *RS*.

The coefficient of linear correlation  $r$  assumes considerably higher values in the case of *MDBD* and has a specific trajectory of variation if compared to an analogous *DBD* discharge in a plasma reactor without magnetic field, [4].

The coefficient  $r$  assumes its lowest value in the area of unstable burning – at the lowest burning pressure of 1.8 Pa, Figure 3.

The region of  $10 \div 100$  Pa as well as the region of the atmospheric pressure can be considered regions of stable burning ( $r > 0.995$ ) with a strongly expressed character of *DBD*, determined by the constancy of the burning voltage.

The existence of a linear correlation between the average value of the current and the effective value of the voltage is an evidence for the constancy of the discharge burning voltage, [1]. Based on the experimental results obtained, it can be assumed that the magnetron effect stabilizes *DBD* and emphasizes its main characteristic.

Discharge burning voltage  $U_{g,1}$  demonstrates a variation, specific for *MDBD*, with pressure  $p$ : almost immediately after entering the area of vacuum the voltage diminishes abruptly to about 0.6 kV – a value that remains constant within the pressure range of  $4 \cdot 10^4 \div 10$  Pa, after which it starts decreasing and attains the lowest value of 0.25 kV. This relationship demonstrates that there exists a certain minimum average length of the free run of the electron (pressure), below which the burning of the discharge becomes difficult, and  $U_{g,1}$  increases abruptly, Figure 5.

This variation of the burning voltage  $U_{g,1}$  of *MDBD* differs significantly from a similar relationship for *DBD*, which in its variation character is similar to the form of the law of *Paschen* – with decreasing of the pressure value below the atmospheric pressure, the burning voltage  $U_{g,1}$  diminishes until reaching its minimum at 10 Pa – the lowest burning voltage of *DBD*, [4].

The critical ignition voltage  $U_{cr,1}$  of *MDBD* follows the variation of the discharge burning voltage  $U_g$ , Figure 5.

The electrical parameters of the first operating area – the rate of discharge current increase (slope)  $B_2$  and intercept  $A_2$  – are also changed with the air pressure  $p$ . The current increase rate  $B_2$  remains relatively low ( $150 \div 200 \mu\text{A/kV}$ ) at pressure values close to the atmospheric pressure (1 atm = 760 mmHg = 101 325 Pa = 1013.25 hPa = 1013.25 mbar) and goes up rapidly, attaining its maximum of  $480 \mu\text{A/kV}$  at about  $10^2 \div 10^3$  Pa. After that it diminishes in a relative smooth manner and at 1.8 Pa attains about  $225 \mu\text{A/kV}$ , Figure 6.

It should be emphasized that in general the slope  $B_2$  and intercept  $A_2$  have lower positive and negative values at the *MDBD* in comparison with those at the *DBD*, Figure 6, [4].

The variation of voltage  $U_{eff}$  with pressure  $p$  at a constant rate of current  $I_{av}$  illustrates well the specific impact of the pressure on the behavior of *MDBD*, Figure 4a.

Increasing of the pressure  $p$  to a value close to the atmospheric pressure determines the abrupt increase in voltage  $U_{eff}$  – from values below 1 kV it attains  $6 \div 8$  kV. Increasing of the current  $I_{av}$  from  $50 \mu\text{A}$  up to  $450 \mu\text{A}$  determines a lesser increase in voltage – from 4 up to 9 kV, Figure 4a.

The abrupt increase in voltage  $U_{eff}$  is determined by the abruptly increasing burning voltage  $U_{g,1}$  of *MDBD* at attaining the atmospheric pressure, Figure 5, while at corresponding increase in the current the voltage  $U_{eff}$  increases as a result of the increasing voltage drop across the ca-

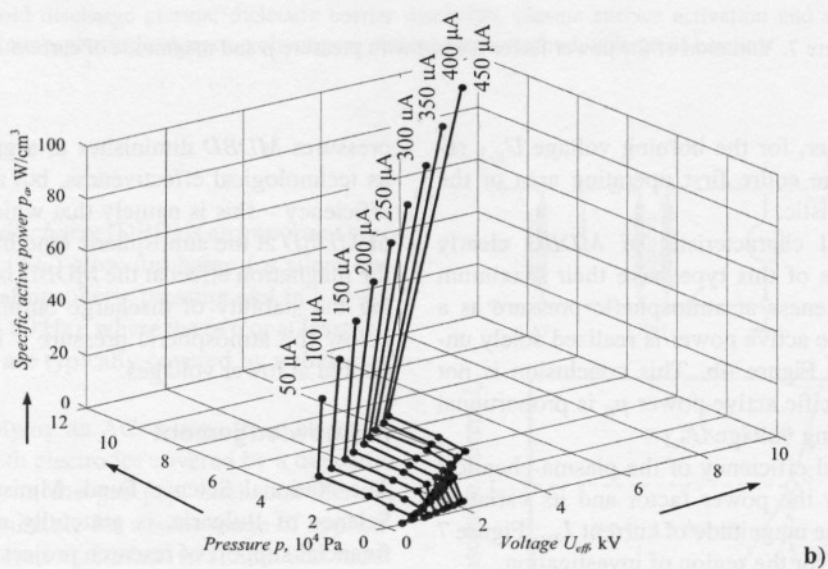
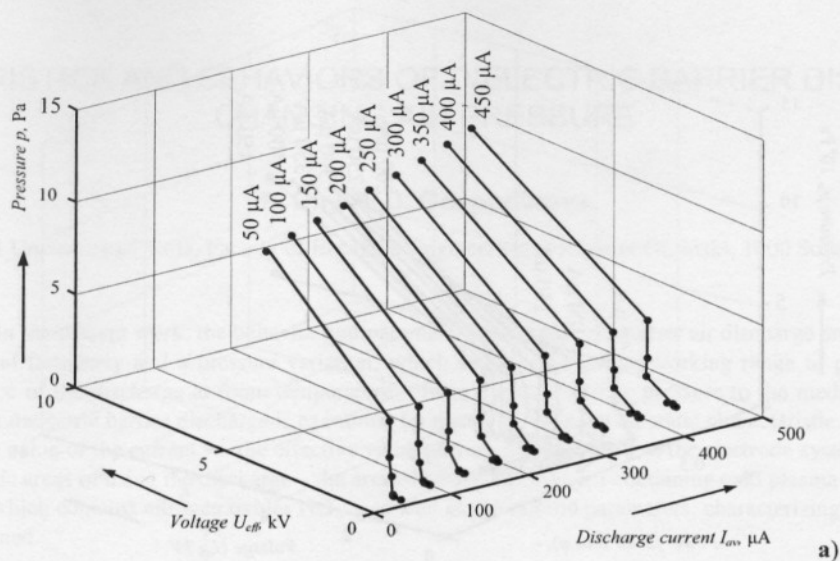


Figure 4. Variation of voltage  $U_{eff}$  (a) and specific active power  $p_a$  (b) of MDBD with pressure  $p$  at constant value of discharge current

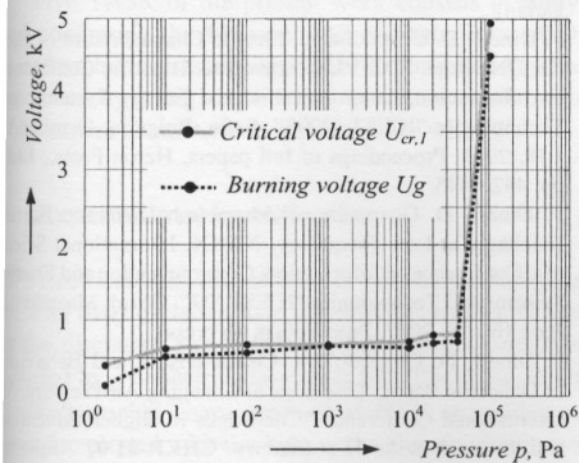


Figure 5. Variation of the burning voltage  $U_{g,1}$  and the critical ignition voltage  $U_{cr,1}$  of MDBD with pressure  $p$ .

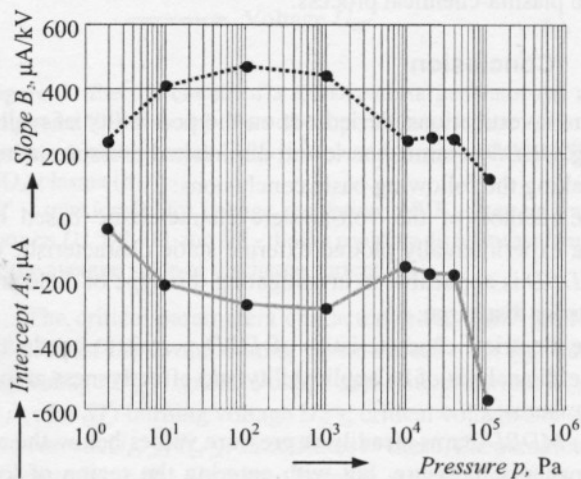


Figure 6. Variation of the current increase rate  $B_2$  and intercept  $A_2$ , characterizing the first operating area of curve RS.



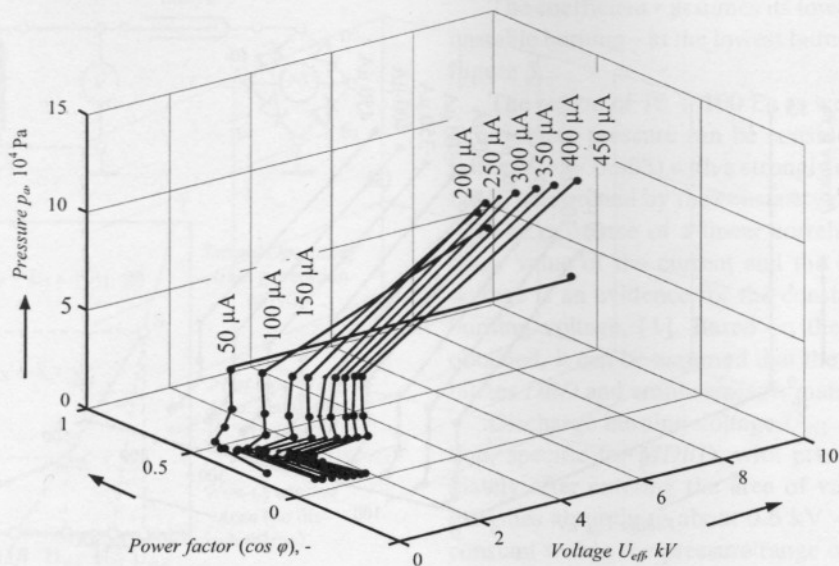


Figure 7. Variation of the power factor ( $\cos \varphi$ ) with pressure  $p$  and magnitude of current  $I_{av}$ .

capitance of the barrier, for the burning voltage  $U_{g,1}$  remains constant for the entire first operating area of the volt-ampere characteristic.

The technological characteristic of *MDBD* clearly shows that discharges of this type have their maximum technological effectiveness at atmospheric pressure as a maximum value of the active power is realized solely under those conditions, Figure 4b. This conclusion is not surprising for the specific active power  $p_a$  is proportional to the discharge burning voltage  $U_{g,1}$ .

The energy-related efficiency of the plasma-chemical process is defined by the power factor and its variation with pressure  $p$  and the magnitude of current  $I_{av}$ . Figure 7 shows said efficiency for the region of investigation.

The power factor decreases considerably with the increase in the current, which should be related to the increasing voltage drop across the capacitance of the barrier. This power is transformed into heat and practically lost for the plasma-chemical process.

#### 4. Conclusion

The investigations carried out on the possibility of realizing *MDBD* at atmospheric and diminished pressures allow making the following basic conclusions:

the method of the volt-ampere characteristic based on the experimentally plotted external static characteristic of *MDBD* is applicable to investigating this type of dielectric barrier discharge;

the electrical characteristics of *DBD* permit to conduct a useful analysis of its applicability and effectiveness at low pressures;

*MDBD* burns steadily at pressure values below the atmospheric pressure, but with entering the region of low

pressures *MDBD* diminishes to a greater extent not only its technological effectiveness, but also its energy-related efficiency – this is namely that which determines the use of *MDBD* at the atmospheric (and higher) pressure; the magnetron effect at the *MDBD* is expressed in improving the stability of discharge burning at pressure values below the atmospheric pressure – it burns and becomes ignited at lower voltages.

#### Acknowledgement

The National Science Fund, Ministry of Education and Science of Bulgaria, is gratefully acknowledged for the financial support of research project VU-TN-205/2006.

#### References

- [1] P. Dineff. *Electrotechnology. Introduction to Electrotechnology*. Technical University, Sofia, Bulgaria, 2000 (in Bulgarian).
- [2] P. Dineff, D. Gospodinova. Electric Characteristics of Barrier Discharge. XXXVI. International Scientific Conference on Information, Communication and Energy Systems and Technologies "ICEST '2003". Sofia, Bulgaria, October 16 - 18, 2003. Proceedings of full papers, Heron Press., Ltd., pp. 442 - 445.
- [3] P. Dineff, D. Gospodinova. Magnetron Dielectric Barrier Discharge at Low Frequency. XXXX. International Scientific Conference on Information, Communication and Energy Systems and Technologies "ICEST '07". Ohrid, Macedonia, June 16 - 18, 2007. Proceedings (in press).
- [4] P. Dineff, D. Gospodinova. Characteristics and Behaviors of Dielectric Barrier Discharge at Changing Air Pressure. V. International Conference "Challenges in Higher Education and Research in the 21-st Century "CHER-21'07", June 05 ÷ 04, 2007, Sozopol, Bulgaria. Proceedings (in press).