

Proceedings
of the
*Ninth International Symposium on the
Science & Technology of Light Sources*
(LS:9)

**Cornell University, Ithaca, NY, USA
12 -16 August 2001**

**Invited Papers and
Abstracts of Landmark and Poster Papers**

Edited by
Rolf S. Bergman
Consultant (formerly GE Lighting)

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Sci Program

Session 0 – Special Opening Lecture
August 12, Sunday Evening, 19:00 – 20:00
Chairman: Charles N. Stewart, Welch Allyn

000:I Systems View of Novel Light Source R& D
J. Maya

Session 1 – HID Lamps & Ballasts
August 13, Monday Morning, 9:00 – 12:30
Chairman: Marco Haverlag, Philips

- 001:I** **New UHP Lamp Technologies for Video Projection**
G. Derra, H. Moench, E. Fischer, X. Riederer
- 002:L** **Mercury-Free High Pressure Discharge Lamps**
M. Born
- 003:P** **Development of a Resistive Thin Film for High Temperature Metal Halide Applications**
A. Inouye, N. Horii, H. Noguchi
- 004:P** **The Pressure Effect & Its Application in Microwave Induced Plasma**
D. Chen, G. Cai
- 005:P** **Spectral Contour of High-pressure Mercury Lamps**
T. Hiramoto
- 006:P** **Reduction of Vertical Segregation in Long and Thin Ceramic High Intensity Discharge Lamps by Longitudinal Acoustic Mode Excitation**
J. Kramer
- 007:P** **Research on a Low Wattage Metal Halide Lamp with Ceramic Envelope for Automotive Headlighting**
J. Hendricx
- 008:P** **Temperature Distribution in a Pulsed High-Pressure Mercury Arc**
M. Kaening, H. Schneidenbach, A. Kloss, H. Schoepp, H. Hess
- 009:P** **Characteristics of Discharge Spectra in Microwave-Induced Electrodeless Sulfur Lamp**
B. Song, D. Hammer
- 010:P** **Development of 220W and 360W Ceramic Metal Halide Lamp with Internal Starter**
Y. Takeji, S. Taniguchi, S. Mori, J. Honda, K. Nakano
- 011:P** **Mercury-free 35W HID Lamps for Automobiles**
S. Omori, M. Muto
- 012:P** **Mercury Free HID Lamps for Automotive Use**
T. Ishigami, K. Uemura, A. Ishiduka, K. Nakano
- 013:P** **Metal Halide Lamps with Improved Lumen Maintenance**
R. Ramaiah
- 014:P** **Color Control Coatings for Metal Halide Arc Lamps**
K. Fullerton, A. Lamouri, E. Krisl, P. Morand, L. Pekker
- 015:P** **Study on High-pressure Mercury Lamp for Rear Projection TV Sets**
M. Horiuchi, M. Kai, T. Seki, T. Ichibakase

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- 016:P **Thermodynamic Aspect of Tungsten Chemical Transport in High Pressure Mercury Lamps**
M. Rahmane, P. Meschter
- 017:P **Short Arc Metal halide Lamp Design for Rear Projection Monitors**
D. M. Rutan, C. N. Stewart
- 018:P **Miniature Metal Halide Lamps: I. Breaking the Efficacy Paradigm**
D. E. Brabham
- 019:P **Miniature Metal Halide Lamps: II. A Study of Flicker and Flare**
D. E. Brabham
- 020:P **Miniature Metal Halide Lamps: III. Extend Lamp Life thru Directed Airflow Cooling**
D. A. Bell, R. A. Mechowski, D. E. Brabham
- 021:P **Duty Cycle Color Control of Metal Halide Lamps**
T. Kelly, H. Zhu, J. Maya
- 022:P **New Microwave Powered Electrodeless HID Lamp with Vane-type Resonator**
A. Hochi, K. Hashimoto-dani, K. Katase
- 023:P **"Electrical Conductivity" Models for Discharge Lamps used for Electronic Circuit Design**
A. Zissis, J.-J. Damelincourt
- 024:P **A Dimmable Electronic Ballast for HPS Lamps with a Novel Ignitor**
W. Zhang, W. Wang, D. Xu
- 025:L **Long Life Ceramic Metal Halide Lamps at 39 W and 20 W**
M. Bugenske, J. Dakin, C. Knittel, J. Tambini
- 026:I **Chemical Complexing and Effects on Metal Halide Lamp Performance**
W. P. Lapatovich, J. A. Baglio

Session 2 – Lamp Diagnostics
August 13, Monday Afternoon, 13:45 – 17:30
Chairman: Lori Brock, Osram Sylvania

- 027:I Electronic Operation of HID Lamps**
R. A. J. Keijser
- 028:L X-Ray Diagnostics in HID Lamp**
J. J. Curry, H. G. Adler, M. Sakai, J. E. Lawler
- 029:P Discharge Trajectory Control in Gas Discharge Lamps using Plasma Acoustic Interaction**
A. Abrahamyan, A. Mkrtchyan, K. Abrahamyan, S. Gevorgyan, R. Kostanyan
- 030:P Experimental Investigations of the Current-Multiplication before the Electrical Breakdown**
K. Ben Yahia, R. Pfendtner, H. P. Popp
- 031:P Spectroscopic Studies of Gas Heating in Pulsed H₂ Capillary-Arc Discharge**
N. Lang, M. Käning
- 032:P A Simple $\Delta\lambda$ -Method for Routine Measurements of Atomic Partial Pressures in Burning HID Lamps**
A. Körber
- 033:P Spectroscopic Studies of High-Pressure Sulfur Vapor in Ultrahigh-frequency Discharges**
J. J. Kim, S. Hong, J. W. Kim
- 034:P $\Delta\lambda$ -Method for Sodium Density Estimation: Modification for Ceramic Metal Halide Lamps**
U. Hechtfischer, A. Körber, F. Nörtemann
- 035:P Blackening of High-Pressure Ar Arc Tubes due to Electrode Erosion**
A. Kloss, W. Graser
- 036:P UV-Visible-IR Fourier Transform Spectroscopy on Metal Halide Lamps**
G. Adler, L. Riley, J. E. Lawler
- 037:P Helical Coil Resonator RF Discharge for High Pressure Outer Jacket Gas Analysis**
J. Gao, J. T. Verdeyen
- 038:P The Role of Water and Hydrocarbon Contamination in Lamp Outer Jackets using BaO₂ Getters and a Method for Detection by FTIR**
T. R. Brumleve, C. R. Freidhof, R. L. Steward, D. L. Miller
- 039:P Method for *In Situ* Measurement of SiI₄ and HgI₂ in Quartz Arc Tubes**
T. Emilsson, T. R. Brumleve
- 040:P Thin Layer Cell for the Observation of UV-Visible Spectra of Molten Salts**
T. Emilsson

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- 041:P Spectroscopic Diagnostics of Metal Halide Lamp Plasma**
K. Hatase, M. Kubo, S. Mori, J. Honda, S. Hashiguchi, J. Tachibana
- 042:P Characterizing Metal-to-Ceramic Seals for High Intensity Discharge Lamps**
S. M. DeCarr, J. C. Grande, M. Gyoer, I. Laher, D. J. Lovett, J. Meszaros,
S. A. Mucklejohn, Z. Toth
- 043:P High Resolution Studies of the Cs High Pressure Lamp**
T. Ban, H. Skenderovic, G. Pichler, J. Liu, K. Guenther
- 044:P Near Infrared Molecular Continua in a Pulsed Cs High Pressure Lamp**
G. Pichler, T. Ban, H. Skenderovic
- 045:P Hg Particle Densities and Electron Temperature for Various Ar Pressures in Narrow Mercury Lamp**
M. Goto, T. Arai
- 046:P Investigations of the Ignition Process in Long Narrow Cold-Cathode Neon Lamps**
G. von Busch, C. Roozkrans, K. Lefki
- 047:P Radiometry of Low-Pressure Hg-Ar Discharges**
C. J. Sansonetti, J. Reader
- 048:P Determination of Water Contamination in Zinc-Mercury Fluorescent Lamp Dose Pellets by Thermal Evolution Infrared Absorption Spectroscopy**
D. L. Miller, R. L. Steward, T. R. Brumleve
- 049:P Excited-state Populations and Resonance Radiation in Highly-Loaded Hg-Ar**
J. J. Curry, G. G. Lister, J. E. Lawler
- 050:P The Electron Energy Distribution and Plasma Parameters of an Ictron Lamp**
V. Godyak, R. Piejak, B. Alexandrovich
- 051:P Fluorescent Tube and Electrode Wear Diagnostics by Photo Emission Spectroscopy**
S. Huldt, R. Hutton, N. Svendenius
- 052:P Raman Microscopic Investigation of Dose-Envelope Interactions in Metal Halide Lamps**
R. Forrest, R. Devonshire, C. V. Varanasi, T. R. Brumleve
- 053:L Raman Database for Lamp Science and Technology**
R. Forrest, R. Devonshire, T. R. Brumleve
- 054:I The Art and Science of Lamp Photometry**
R. S. Bergman, Y. Ohno

**Session 3 – Lamp Electrodes,
Incandescent Lamps & Non-Lighting Applications
August 14, Tuesday Morning, 8:15 – 12:30
Chairman: Katsuhide Misono, Toshiba**

- 055:I** **Diagnostics of HID Electrodes**
J. Mentel, L. Dabringhausen, S. Lichtenberg, J. Luhmann, D. Nandelstaedt,
M. Redwitz
- 056:L** **Emitter Free Tungsten Electrodes in High Pressure Discharge Lamps**
T. Hartmann, K. Günther
- 057:P** **Electrode Diagnostics in High Pressure Discharge Lamps**
T. Hartmann, K. Günther
- 058:P** **Determination of Plasma Parameters near the Electrodes of Short Arc Lamps**
M. Kettlitz, H. Pursch
- 059:P** **Dynamic Mode Change of Arc Attachment on the Cathode of AC High-
Pressure Mercury Discharges**
H. Pursch, H. Schoepp, M. Kettlitz, H. Hess
- 060:P** **Experimental Investigations of Locally and Temporally Resolved Electrode
Temperature Distributions of HID-Lamps using
a 3- λ -Pyrometric Method**
C. Bauer, M. Neiger, H. Mönch, T. Krücken
- 061:P** **Determination of Electrode Falls in a Model Lamp**
M. Redwitz, L. Dabringhausen, S. Lichtenberg, J. Mentel
- 062:P** **Measuring the RF-Impedance of a Low Current Argon Arc**
S. Lichtenberg, J. Luhmann, J. Mentel
- 063:P** **First-Principles Calculations on Coverage Dependent Work Function and its
Implication for Cathode Temperatures: Sodium Vapour Lamps**
J. Almanstoetter, B. Eberhard
- 064:P** **Experimental and Theoretical Investigation of the Glow-to-Arc Transition in
Metal Halide Lamps**
J. Gao, T. R. Brumleve
- 065:P** **Numerical Modeling of the Dynamic ESV Electrode Sheath Voltage for
a 0.62 MPa Mercury Discharge**
R. Böttcher, W. Böttcher
- 066:P** **Modes of Cathodic Arc Attachment to Electrodes for HID Lamps**
L. Dabringhausen, M. Redwitz, D. Nandlestädt, J. Mentel
- 067:P** **Simulation of Spot-Diffuse Transition on AC-Operated HID Lamp Electrodes**
W. Graser
- 068:P** **Time Resolved Recording of Arc Spot Formation on Cold Cathodes**
S. Frohnert, M. Schumann, P. Storck, J. Mentel

Sci Program

- 069:P Investigations on Ba Depletion from Electrodes in Low-Pressure Hg/Noble Gas Discharge Lamps using ^{133}Ba Tracer Techniques, Fast Photog. and SEM**
T. L. G. Thijssen, A. van der Heijden, B. Buijsse, W. J. van der Hoek
- 070:P Effect of Electrode Geometry on Thermionic Emission for the Starting of Fluorescent Lamps**
D. K. Gupta, G. Zissis
- 071:P Measurement of Barium Evaporation Rates for F-lamp Cathodes using Laser Induced Fluorescence**
J. D. Michael
- 072:P The Chemistry of Triple-Oxide Cathodes**
S. Bott, R. Forrest, R. Devonshire., E. Arnold, G. Desinger
- 073:P Effect of Auxiliary Heating on Barium Loss from Fluorescent Lamp Electrode under HF Operation**
K. Misono
- 074:P Calculation of Complex Index of Refraction of Tungsten using Ellipsometer**
S. Sekine, A. Sato, M. Ohkawa
- 075:P Analysis of Electrodes from Metal Halide Lamps**
C. V. Varanasi, T. R. Brunleve
- 076:P Time-dependent Thermionic Cathode Model for High Intensity Discharge Lamp Starting**
Y-M. Li, B. Budinger
- 077:P Modeling the Temperature Distribution in Cathodes of HID Lamps**
M. Benilov, M. Cunha
- 078:P Adjust Emission Spectrum of the Incandescent Lamp by Optical Interference Coatings**
D-L. Lu, W. Qui, X-W. Lu, Y-S. Zhou, Z-G. Lu
- 079:P On Energy-Saving of Incandescent Lamp with IR Reflective Coating**
Z-G. Lu, D-L. Lu, W. Qiu, A-H. Gao, X-W. Lu
- 080:P Application of Powdered Getter of Red Phosphorus in Ground Glass Incandescent Lamps**
P. Zhongzhui
- 081:P Shaping of the Vortek Water Wall Arc Lamp Spectrum**
T. Thrum, F. Dawson, D. Camm
- 082:P Machine Vision Illuminating System for Handheld Bar Code Scanning Systems**
W. Havens, V. Hunter
- 083:L Electrode Diagnostics for HID-Lamps**
H. G. Adler
- 084:I Trends in Environmentally Friendly HID Technology**
N. Saito

Session 4 – Lamp Models & Novel Discharges

August 14, Tuesday Afternoon, 13:45 – 17:30

Chairman: Sylvain Coulombe, GE

- 085:I A Simulation Model of HID Lamps based upon an Energy Balance**
T. Ishigami
- 086:L Breakdown Processes in Metal Halide Lamps**
T. J. Sommerer, D. Wharmby, J. G. Eden, M. J. Kushner
- 087:P Radiative Transfer in the General Plasma Simulation Package Plasimo**
H. van der Heijden, J. van der Mullen
- 088:P Simulations of Electrode Temperatures in HID Lamps**
T. Krücken
- 089:P Spectral Line Shape Modeling in HF-Discharge**
I. Bersons, G. Revalde, A. Skudra
- 090:P Self-Consistent Modeling of Convection in High Pressure Mercury Lamps**
X. Zhu, J. van Dijk, H. van der Heijden, J. van der Mullen
- 091:P Modeling of High Pressure Discharge Lamps Including Convection**
T. Grau
- 092:P Simulating the Spectrum of a High-pressure Sulfur Discharge**
C. Johnston, H. van der Heijden, G. Janssen, J. van Dijk, J. van der Mullen
- 093:P Acoustic Resonance in Low Power Ceramic Metal Halide Lamps**
S. H. Howe, S. Coulombe
- 094:P Modeling the Arc-Cathode Interaction in Super-High-Pressure Arc Discharges**
S. Coulombe, M. S. Benilov
- 095:P Estimation of the Momentum Transfer Cross Section for Collisions of Electrons with Iodine Atoms for the Modeling of High Pressure Metal Halide Lamps**
B. Schalk, L. Hitzschke, G. H. Lieder, G. Hartel
- 096:P Time-dependent Two-dimensional Fluid Model of a Metal Halide Lamp**
S. Hashiguchi, K. Hatase, S. Mon, K. Tachibana
- 097:P Using Brightness and Color Gamut to Assess Spectra Optimized for Luminosity and Color Rendering**
T. J. Sommerer
- 098:P Validating a Combined Mercury-Neon Collisional Radiative Model**
B. Hartgers, A. Stijfs, L. Bakker, J. van der Mullen
- 099:P Modeling a Fluorescent Lamp Plasma Using a Simple 3-Electron Temperature Approximation**
B. Hartgers, J. van der Mullen

Sci Program

- 100:P Computation of the Mercury Vapor Pressure above Multicomponent Fluorescent Lamp Amalgams**
S. C. Hansen, S. L. Chen
- 101:P Low Temperature DC Plasma Modeling Using the Lattice Boltzmann Method**
M. Jinno, A. Keer-Rendon, R. Devonshire
- 102:P The Dynamic Behaviour of Pulsed Low-Pressure Discharges: The Grotrian Model**
G. Moss, R. Devonshire
- 103:P A Critical Comparison of LTE vs. Kinetic Approaches in the Modeling of Lamp Chemistry**
A. Keer-Rendon, N. Powell, G. Wilson, R. Devonshire
- 104:P Effect of External Irradiation on the Leakage Time Constant in a Sleeve Discharge and the Associated Light Effect**
S. S. Pimpale, S. G. Pimpale
- 105:P Mechanism of Negative Space Charge in a Discharge of Argon Subjected to Ionisation by Collision**
S. S. Pimpale, S. G. Pimpale
- 106:P Behaviour of Positive Space Charge in Parabolic Segments of Current Emission through Argon Subjected to Corona Discharge**
S. S. Pimpale, S. G. Pimpale
- 107:P Investigation of Lamp Fills for Hg-free Microwave-Excited HID Lamps**
B. Koch, M. Neiger
- 108:L Time-dependent Modeling of High Pressure Discharge Lamps including Electrodes**
P. Flesch, M. Neiger
- 109:I Aperture Lamps**
D. A. Kirkpatrick

Session 5 – Solid State Lamps
August 15, Wednesday Morning, 8:15 – 12:30
Chairman: Ernst Smolka, Heraeus

110:I Another Semiconductor Revolution: This Time it's Lighting
R. Haitz

111:I Light Emitting Diodes as Light Sources
N. Narendran

There is no Poster Session, only a long Coffee Break

112:I Recent Advances in Organic Light Emitting Diodes
R. Kwong, M. Lech, M. Nugent, K. Rajan, T. Ngo, J. J. Brown, S. Lamansky,
P. Djurovich, D. Murphy, F. Abdel-Razzaq, J. Brooks, M. E. Thompson,
C. Adachi, M. Baldo, S. R. Forrest

113:I Monolithic LED Arrays on Silicon Nano-Structures
J. R. Shealy, Y. Wang, N. C. Mac Donald

114:L Binary Rare Gas Mixtures for Mercury-Free Signs
H. Sarroukh, E. Robert, C. Cachoncinlle, R. Viladrosa, J. M. Pouvesle

**115:L New Low-pressure Gas-Discharge Source of Optical Radiation
using Hydroxyl, OH**
M. Khodorkovskii, S. Kidalov, V. Milenin, N. Timofeev, A. Vul

Sci Progarm

Session 6 – Lamp Materials

August 15, Wednesday Afternoon, 13:45 – 16:30

Chairman: Timothy Brumleve, APL

- 116:I Recent Studies on Fused Quartz and Synthetic Fused Silica for Light Sources**
H.-D. Witzke
- 117:L The Relevance of Gaseous NaAlX₄ (X=Br,I) Hetero Complexes for the Operation of Metal Halide Lamps with Ceramic Envelopes**
T. Markus, U. Niemann, L. Singheiser, K. Hilpert
- 118:P High Efficiency and High Visibility Shaded Reflector Type LEDs**
Y. Suehiro
- 119:P LCD Backlighting with High Luminescent Colored Light Emitting Diodes**
C. Hoelen, G. Harbers
- 120:P Ultraviolet Enhancers made from Polycrystalline Alumina to Eliminate Ignition Delay**
T. P. C. M. Vos, G. M. J. F. Luijks, W. J. van den Hoek
- 121:P Protection of Quartz Glass Surfaces in Excimer Lamps against Halogen Attack by Sol-Gel Coatings of Al₂O₃**
E. Arnold, F. Schilling, H.-D. Witzke, C. Doppleb, R. Hirrlé
- 122:P Carbon Blackening in Ceramic Metal Halide Lamps**
H. Honda, S. Ashida
- 123:P Evaluation of the Mechanical Properties of HID Sealing during Ageing**
Z. Toth, A. Juhasz, B. Nyiri
- 124:P Changes in Dose Composition at Different Stages of Life in Metal Halide Lamps Containing NaI-ScI₃-ThI₄**
C. V. Varanasi, T. R. Brumleve, T. Emilsson
- 125:P The Rheology and Mechanical Properties of Ceramic Suspensions near Critical Conditions**
V. Gauri, D. Polis
- 126:P New Getter Material for Discharge Lamps**
A. Corazza, C. Boffito
- 127:P High Temperature Stable Colored Sol-gel Coatings for Automotive Signaling Lamps**
R. Broersma
- 128:P New Transparent Substrate with Silica Aerogel Film for Surface-Emissive Devices**
K. Kawano, T. Tsutsui, M. Yahiro, Y. Shigesato, H. Yokogawa, M. Yokoyama
- 129:P Vacuum Ultraviolet Excitation Spectra of Boron-Rich Borate Phosphors Activated with Tb³⁺ and Eu³⁺**
S. Tanimizu, T. Suzuki, M. Shiiki, C. Okazaki

Sci Program

- 130:P Research on the Optical Properties of Alumina-Phosphor Coating**
D. Fang, X. Zhang, F. Li
- 131:P New Hg Dispensers for Cold Cathode Lamps**
A. Corazza, P. Gallina, S. Giorgi
- 132:P Photolytic Dehydration of Coating Surfaces during Lamp Operation
Influencing Mercury Binding, Lumen Maintenance and Lamp Life**
J. B. Jansma, E. E. Hammer, S. Han
- 133:I Recent Developments in Multiphoton Emitting Phosphors for Fluorescent
Lamps and Display Devices**
A. M. Srivastava

Busses to Barbeque / Banquet leave Hotels at 15:30

**Session 7 – Fluorescent Lamps,
Excimer and Dielectric Barrier Discharge Devices**

August 13, Thursday Morning, 8:15 – 12:00

Chairman: John Stocks, SLI

- 134:I** **Product Families based on Dielectric Barrier Discharges**
L. Hitzschke, F. Vollkommer
- 135:L** **Cataphoresis Phenomenon of Fluorescent Lamps with HF Electronic Ballasts**
H. Nagai, K. Honda, N. Hashimoto, K. Sato, N. Miki, Y. Yamanaka
- 136:P** **The Influence of Impurities on the VUV-Emission of Dielectric Barrier Discharges**
F. Adler, S. Mueller, R.-J. Zahn
- 137:P** **Calculations of Kr-Xe Mixture Barrier Discharge Parameters**
G. Zvereva, G. Gerasimov
- 138:P** **Luminous Improvement of Xenon Dielectric Barrier Discharge Lamps**
M. Aono, H. Motomura, M. Jinno, T. Ikeda
- 139:P** **High Power UV and VUV Excilamps**
V. F. Tarasenko, M. V. Erofeev, M. I. Lomaev, A. Panchenko, D. V. Shitz,
V. S. Skakun, E. A. Sosnin
- 140:P** **Xe(He)-I₂ Glow and Capacitive Discharge Excilamps**
M. I. Lomaev, V. F. Tarasenko
- 141:P** **Influence of Excitation Pulse Form on Barrier Discharge Excilamps Efficiency**
M. I. Lomaev, D. V. Shiitz, V. S. Skakun, V. F. Tarasenko
- 142:P** **VUV Radiation from a Pulsed Xe Micro-Hollow Cathode Discharge**
E. Davliatchine, F. Adler, E. Kindel
- 143:P** **The Dynamical Behaviour of Pulsed Low Pressure Discharges: Near-UV Emitters**
S. Kitsinelis, R. Devonshire
- 144:P** **High Frequency Cold Ignition Process of Compact Fluorescent Lamps**
M. Haverlag, A. Kraus, J. Sormani
- 145:P** **Steady-State Direct Current Operation of Low Pressure Argon-Mercury Discharges**
J. Gielen, S. de Groot, J. van Dijk, J. van der Mullen
- 146:P** **Emission Characteristics of Xenon Fluorescent Lamp with Inner and Outer Electrodes**
H. Noguchi, H. Motomura, M. Aono, H. Yano
- 147:P** **Novel Flat Compact Fluorescent Lamp**
M. Anandan, J. Ravi, T. Uetsuki, S. Lambrechts

Sci Program

- 148:P Mercury Free Xe Flat Fluorescent Lamps for Illumination**
T. Shiga, Y. Ikeda, S. Mikoshiba, S. Shinada
- 149:P On Slimmer Discharge Tube Diameter Compact Fluorescent Lamp**
Z-G. Lu, D-L. Lu, W. Qiu, X-W. Lu, Y-S. Zhou
- 150:P High Lumen, High CRI Spectra for Fluorescent Lamp Applications**
T. F. Soules, M. Grecci, E. E. Hammer
- 151:P Ferrite-Free High Output (100 - 600 kHz) Electrodeless Fluorescent Lamp**
O. A. Popov
- 152:L Ceralight(TM) - A New Superior Cold Cathode Fluorescent Lamp**
A. Kraus, B. Rausenberger, W.-A. Groen
- 153:I Positive Column Model of Highly Loaded F-lamps**
G. G. Lister