Research Group / Laboratory of :

LASER DEVELOPMENT and APPLICATIONS

Physics Department, National Technical University of Athens

Members of the Research Group

Academic Staff:

1. Alex A. Serafetinides (Professor)
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3. Alexandros Papayannis (Associate Professor)
4. Ioanna Zergioti (Assistant Professor)

Ph.D. Students:

1. E. Drakaki, M.Sc.
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5. C. Boutopoulos, M.Sc.
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Part-time Research Fellows:

1. E. Fabrikezi, Ph.D.
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4. M. Kandyla, Ph.D.
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Research Activities

A. Development of Gas and Solid-state lasers (UV & mid-IR)

1. Development of mid-IR solid-state lasers (?=3.0 μm, Er:YAG)

- Design and development of discharge circuits and optical pumping techniques, optical resonators, Q - switching techniques,
- Stability conditions in optical resonators

2. Development of chemical vibrational-rotational lasers (HF)

- Development of novel pre-ionization conditions in electro-negative gases (SF_6),
- Evaluation of de-excitation rates, simulation of transitions in SF_6+C_3H_8 gases, selection rules,
- Competition phenomena in novel optical resonators, resonator conditions, gain evaluation of chemical reactions.

3. Development of self-terminated lasers (N_2)

- Population inversion from short lifetime laser levels,
- Novel pumping and pre-ionization techniques for short lifetime laser action (Blumlein, plasma cathode etc.),
- Long pulse durations in "self-terminating" laser systems.

4. Development of eye-safe lasers (Ar)

- Population inversion in atomic systems of noble gases,
- Laser action beyond the upper limit of the transmission curve of opthalmic tissues,
- Laser action from low-gain transitions

5. Double beam laser systems (HF and N_2)

- Conditions for simultaneous amplification of UV and mid-IR radiation in gas mixture. Double hole burning in gain curves,
- Simultaneous laser action in optical resonators in the UV and mid-IR part of the spectrum.

B. Testing and Evaluation of Optical Fibers and Waveguides (UV-IR)

1. Testing and evaluation of waveguides from Japan. Israel, Greece

2. Testing and evaluation of optical fibers from U.S.A., Russia, France

C. Laser Applications

1. Short (ns, ps, fs) laser pulses interaction with technological materials

- Study of material and bio-material properties using short laser (ns, ps, fs) pulses (linear & non linear effects)

2. Stimulated Raman Scattering (SRS) in single-pass high-pressure cells (H_2, H_2+He, D_2) using the Nd:YAG laser as excitation source (355 nm)

- **Simultaneous production of multiple laser lines in the UV-VIS (280-500 nm) for biomedical and environmental applications,**
- **Optimization studies on the SRS technique (H_2, H_2+He, D_2) using the Nd:YAG laser as excitation source (355 nm)**

3. Study of electro-optical materials ($LiNbO_3$)

- **Solving of Q-switching equations, evaluation of $V_{?/2}$ and $V_{?/4}$ voltage of $LiNbO_3$ crystals,**
- **Design of novel laser optical resonator under Q - switching regime**

4. Ablation of biopolymer materials

* **Ablation studies of biopolymer and biomaterials using pulsed CO_2, HF, Nd:YAG και Er:YAG lasers**

5. Human tissue spectroscopy

* **Detection of pathological tissues using Laser Induced Fluoresence techniques**

* **Construction of mathematical algorithms for evaluation of the spectra**

6. Air Pollution Monitoring

- **Design and development of UV-VIS solid-state LIDAR systems for air pollution monitoring (O_3, SO_2, NO_X, suspended particles) *,**
- **Development of real-time LIDAR data acquisition and processing using the LabVIEW code.**

7. Industrial Applications of lasers

- **Laser triangulation techniques applied in 2D artificial vision for industrial applications,**
- **Spectroscopy studies of welding arcs for industrial robotic applications**

8. Evaluation of laser beam-materials interaction using SEM and AFM techniques

Research Projects

EPET-II/GGET"Novel laser-based robotic sensors for industrial quality control (EXESIO)", (1995-1998).

EPET-II/GGET"Development of merthods and techniques for endoscopic surgery (ENDOS)", (1995-1998).

PENED/GGET"Development of a novel c.w. and pulsed frequency tunable HF/DF laser. Applications for biomedical and environmental applications", (1996-1998).

TMR/EEC
"Airborne LIDAR Tomography for Air Pollution Plume Tracking in the Eastern Mediterranean" (1996).

ENVIRONMENT/EEC
"Photochemical Activity in the Ultraviolet Spectral Region - PAUR-II", (1998-2000).

Collaborating Institutes / Universities

1. **Essex University / Physics Department, UK**
2. **Herriot-Watt University / Physics Department, UK**
3. **Ecole Polytechnique de Geneve / Physics Department, Switzerland**
4. **Bulgarian Academy of Sciences / Institut of Electronics, Bulgaria**
5. **Medical University of Bucharest / Biophysics Research Department, Romania**
6. **Tohoku University, Electr. Communications Dept., Sendai, Japan**
7. **University of Paris VI, Physics Department, France**
8. **National Physical Laboratory, U.K.**
9. **University of Sao Paolo, ICNEN, Brazil.**
10. **Technical University of Poznan, Physics Department, Poland.**

Recent Publications

1. E. Sobol, M. Makropoulou, A. Serafetinids, D. Yova, "Theoretical model of CO_2 laser ablation of soft-tissue phantoms", *Il Nuovo Cimento D*, **18**, 483, 1996.

2. G. Tsikrikas, A. Serafetinides, A. Papayannis, "Performance studies of a pulsed HF laser with a sliding discharge plasma cathode", *Applied Physics B* **62**, 357-365, 1996.

3. G. Tsikrikas, A. Serafetinides, A. Papayannis, "Development of a sliding discharge pumped HF Laser", *Optics Communications*, **132**, 295-301, 1996.

4. G Tsikrikas, A. Serafetinides, "Effect of voltage pulse polarity on the performance of a sliding discharge pumped HF laser", J. *Physics D., Applied Physics*, **29**, 2807, 1996.

5. G Tsikrikas, A. Serafetinides, "Discharge and circuit simulation of a plasma cathode TEA HF laser with a $He/SF_6/C_3H_8$ gas mixture", *Optics Communications*, **134**, 145, 1997.

6. F. Marenco, V. Santacesaria, A. Bais, D. Balis, A. Di Sarra, A. Papayannis, C. Zerefos, "Optical properties of Mediterranean maritime aerosols determined by Lidar and spectrophotometric measurements during the PAUR Campaign", *Applied Optics* 6875-6886, 1997.

7. A. Serafetinides, G. Tsikrikas, A. Papayannis, P. Atanasov, "Simultaneous emission of the HF and N2 lines from a Plasma Cathode TEA laser", IEEE J. Quant. Electr., 33, 2167-2173, 1997.

8. G.N. Tsikrikas and A.A. Serafetinides, "Discharge and circuit simulation of a plasma cathode T.E.A. HF laser with a $He/SF_6/C_3H_8$ gas mixture", *Optics Communications*, V.134, p.145, 1997.

9. C.D. Scordoulis, M.I. Makropoulou, A.L. Bolovinos and A.A. Serafetinides, "XeCl laser ablation of biocompatible P.T.F.E. studied by photothermal beam deflection", *Lasers in Medical Science,* V.12(4), p.313, 1997.

10. A.A. Serafetinides, G.N. Tsikrikas, A.D. Papayannis and P.A. Atanasov, "Simultaneous emission of the HF and N_2 lines from a plasma cathode T.E.A. laser", *I.E.E.E. Journal of Quantum Electronics,* paper accepted (7-5-1997).

11. A. Papayannis, D. Balis, "Study of the Structure of the Lower Troposphere over Athens Using a Backscattering Lidar During the MEDCAPHOT-TRACE Experiment: Measurements over a semi-urban Area", *Urban Environment (MEDCAPHOT-TRACE Special Issue)* (in press, 1998).

12. A. Papayannis, A. Bais, D. Balis, H. Van Der Bergh, B. Calpini, E. Durieux, L. Fioranni, L. Jaquet, I. Ziomas and C. Zerefos, "The role of urban and suburban aerosols on solar UV radiation over Athens, Greece", *Urban Environment* (MEDCAPHOT-TRACE Special Issue), (in press, 1998).

13. A.A. Serafetinides, C.D. Scordoulis, M. Makropoulou and A.K. Kar, "Picosecond and subpicosecond visible laser ablation of optically transparent polymers", *Applied Surface Science,* (paper submitted, 1998).

14. A.A. Serafetinides, M.G. Khabbaz, M. Makropoulou and A.K. Kar, "Picosecond laser ablation of dentin", *Lasers in Medical Science,* (paper submitted, 1998).

Participations at International Conferences

1) Makropoulou, A. Serafetinides, E. Kovacs, “Biophysics of laser ablation: the role of water absorption”, *XIIth Int. Biophysics Congress*, Amsterdam, 1996.

2) A. Serafetinides, M. Makropoulou, A. Kar, M. Khabbaz, Picosecond and femtosecond laser ablation of hard tissues”, *Biomedical Optics Europe*, Vienna, Austria, 1996.

3) A. Serafetinides, “Short pulse laser beam interactions with polymers, biocompatible materials and tissue”, *9th Int. School on Quantum Electronics*, 16-20 September 1996, Varna, Bulgaria.

4) A. Serafetinides, K. Scordoulis, M. Makropoulou, A. Kar, “Femtosecond laser ablation of polymers”, *9th Int. School on Quantum Electronics*, 16-20 September 1996, Varna, Bulgaria.

5) N. Anastassopoulou, B. Arapoglou, P. Demakakos, M. Makropoulou, A. Paphiti, Y. Raptis, A. Serafetinides, “LIF as a diagnostic tool in atherosclerosis*”, 9th Int. School on Quantum Electronics*, 16-20 September 1996, Varna, Bulgaria.

6) F. Marenco, A. Papayannis, D. Balis, V. Santacesaria, "Aerosol measurements in urban areas of Greece using a simple backscattering lidar", *18th Int. Laser Radar Conference*, 22-26 July 1996, Berlin, Germany.

7) A. Papayannis, G. Ancellet, R. Barbini, J. Boesenberg, B. Calpini, W. Diehl, M. Milton, M. Del Guasta, T. Trickl, "Large-scale European Network of laser remote sensing facilities for environmental an industrial monitoring of toxic and Global Change related trace gases (HCM Lidar Network)", *18th Int. Laser Radar Conference*, 22-26 July 1996, Berlin, Germany.

8) G. Agapiou, A. Economou, C. Kassiouras, S. Kontoyannis, A. Papayannis, A. Serafetinides, M. Siniyalia, "Development of a Laser-Based Seam Tracking System for Real-Time Industrial Robot Welding Applications", 9th Int. School on Quantum Electronics, 16-20 September 1996, Varna, Bulgaria.

9) A. A. Serafetinides, M. Khabbaz, M. Makropoulou, A.K. Kar, “Picosecond Laser Ablation of Dentin”, 8th Congress of the European Society of Endodontology, Gothenburg, 12 - 14/6/97, Sweden, 1997.

10) M. Makropoulou, C.D. Skordoulis, A.K. Kar, “Ultra-Short Pulsed Laser Ablation of Biopolymers and Hard Tissues”, A.A. Serafetinides, CLEO/Pacific Rim ‘97, Chiba, 14 - 18/7/97, Japan, 1997.

11) A. Serafetinides, K.R. Rickwood, N. Anastassopoulou, Y. Wang, Y.-W. Shi and M. Miyagi, “Pulsed HF laser radiation transmission through FCP - coated silver hollow glass waveguides”, BiOS Europe 97 Conference, San Remo, Italy, 1997.

12) A. Papayannis, G. Tsikrikas, A. Serafetinides, ‘Stimulated Raman scattering in H_2 and D_2 using a pulsed Nd:YAG laser at 355 nm’*, 2nd Greek-Italian International Conference on New Laser Technologies and Applications*, 1-4 June, 1997, Ancient Olympia, Greece.

13) M. Makropoulou, A. Papayannis, A. Serafetinides, K. Skordoulis, ‘Ultraviolet and visible laser ablation of polymers’, *2nd Greek-Italian International Conference on New Laser Technologies and Applications*, 1-4 June, 1997, Ancient Olympia, Greece.

14) A. Serafetinides, K. Rickwood, A. Papayannis, Y. Wang, Y. Shi, N. Miyagi, N. Croitoru, J. Harrington, R. Nubling, ‘Flexible waveguides and fibers for 3.0 micron laser radiation delivery in medical applications’, *2nd Greek-Italian International Conference on New Laser Technologies and Applications*, 1-4 June, 1997, Ancient Olympia, Greece.

15) A. Papayannis, D. Balis, J. Porteneuve, E. Galani, “Development of a new ozone DIAL system for tropospheric and lower stratospheric ozone monitoring in N. Greece”, EGS XVII General Assembly, 20-24/4/98, Nice, France.

16) A. Serafetinides, M. I. Makropoulou, "Pulsed laser ablation of hard tissues: Theoretical and experimental considerations", VI International Conference of the European Medical Laser Association (EMLA), 2-6/6/98, Bucharest, Romania.

17) E. Drakaki, N. Anastassopoulou, M. Makropoulou, and A.A. Serafetinides, "Optical properties of tissue phantoms: measurements of laser induced fluorescence emission, excited by a pulsed UV laser", CLEO-Europe Summer School -SUSSP 52 on Advances in Lasers and Applications", September 1998, University of St Andrews, Scotland, UK.

18) E. Drakaki, N. Anastassopoulou, I. Raptis, A.A. Serafetinides, A. Pafiti, B. Tsiligiris, B. Arapoglou, M. Makropoulou, and P. Demakakos, “Laser Excited Autofluorescence for Discrimination of Atherosclerosis", BiOS Europe '98,

the European Biomedical Optics Week, 8-12 September 1998, Stockholm, Sweden.

19) E. Drakaki, M. Makropoulou, E. Mallas and A.A. Serafetinides, "Dosimetry in Photodynamic Therapy by Laser Induced Fluorescence Spectroscopy", "Xth International School of Quantum Electronics", September 1998, Varna, Bulgaria.

20) N. Anastassopoulou, G. Chourdakis, E.T. Fabrikesi, A.A. Serafetinides, Y. Matsuura, Y-W. Shi and M. Miyagi, "Bending loss in mid-infrared waveguides and fibres", OWLS V, International Conference on Optics Within Life Sciences, 13-16/10/98, Heraklion, Crete.

21) N. Anastassopoulou, E. Drakaki, M. Makropoulou, Y.S. Raptis, A. A. Serafetinides, A. Paphiti, B. Tsiligiris, B. Arapoglou and P. Demakakos, "Laser induced fluorescence in atherosclerotic plaque with different excitation wavelengths", OWLS V, International Conference on Optics Within Life Sciences, 13-16/10/98, Heraklion, Crete.