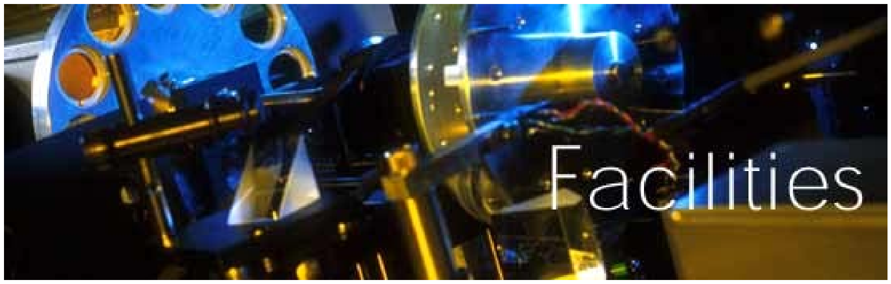

The Tools for Studying Light

From its very beginnings, the Spectroscopy Laboratory has recognized that world-class research requires state-of-the-art equipment. As a result, the Laboratory strives to maintain a diverse collection of laser systems for the purpose of fundamental and applied research in modern optics and spectroscopy. In addition, the Spectroscopy Laboratory houses two independently funded research facilities, the Laser Biomedical Research Center (LBRC) and the MIT Laser Research Facility (LRF). Although these two facilities have different missions and operate in parallel within the Laboratory, researchers benefit from these facilities by sharing technical information and equipment.

As an organizational unit, the Spectroscopy Laboratory consists of a collection of main and auxiliary laboratories, having one of the largest and most diverse collections of lasers and instrumentation in an academic environment. The following list describes the various facilities and equipment available, as well as a brief overview of the ongoing research objectives. The principal investigator responsible for each laboratory is indicated.

Main Laboratories and Facilities

Physical Sciences (LRF) and Biological Sciences (LBRC):

1. Tunable Raman Facility

Biological Sciences (LBRC):

1. Tissue Culture Facility
2. Tri-Modal Spectroscopy and Microscopy Laboratory
3. Raman Biomedical Spectroscopy Laboratory
4. Tunable Raman Facility
5. Interferometry Laboratory
6. Light Scattering Laboratory
7. Light Scattering Spectroscopy Imaging Laboratory
8. Optical Probe Facility
9. Pico/Femto Dynamics

Auxiliary Laboratories and Facilities

Physical Sciences (LRF):

1. Pulsed Visible/UV Spectroscopy/ Molecular Dynamics
2. Time-Resolved Spectroscopy of Nanostructured Materials
3. Femtosecond Non-Linear Spectroscopy of Condensed Phases
4. Picosecond Time-Resolved Spectroscopy
5. Pulsed Visible/UV Spectroscopy and Combustion Kinetics
6. Picosecond Laboratory
7. Raman Micro-Spectroscopy Facility

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Laser Biomedical Research Center (LBRC)

The Laser Biomedical Research Center was established in October 1985 as a National Research Resource Center in laser biomedicine under support of the Biomedical Research Technology Program of the National Institutes of Health. The LBRC's mission is to develop the basic scientific understanding and new techniques required for advancing the clinical applications of lasers and spectroscopy.

Researchers use the LBRC's resources to exploit laser-based spectroscopic techniques for medical applications such as the spectral diagnosis of disease, investigation of biophysical and biochemical properties of cells and tissues and development of novel imaging techniques. A unique feature of the LBRC is its ability to form strong clinical collaborations with outside investigators in areas of common interest that further the Center's mandated research objectives. For example, ongoing clinical collaborations are using spectroscopic instruments developed at the Center to diagnosis precancer in various organs.

National Research Resource Center

As a National Research Resource Center, the LBRC makes available its facilities, along with technical and scientific support, to outside researchers for the purpose of pursuing independent research projects in the area of laser biomedical applications. The facilities are available on a time-shared basis, free-of-cost policy to qualified scientists, engineers and physicians throughout the United States. For additional information, please read the Guidelines for Use of LBRC Facilities.

National Institutes of Health

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National Science Foundation

MIT Laser Research Facility (LRF)

Founded in 1979, the MIT Laser Research Facility is supported by the National Science Foundation. The mission of the LRF is to function as a common resource for advancing new laser technologies and novel spectroscopic techniques in the physical sciences at MIT. An important focus of the LRF is the application of new spectroscopic techniques, development of new instrumentation and methods for analysis in the furtherance of fundamental scientific advances and the generation of new technologies.

Physical science research in the LRF covers a wide range of projects. Nine MIT faculty members and their groups in chemistry, physics and engineering use LRF instrumentation to explore the structure and dynamics of atoms, molecules and nano-materials. These studies require specialized equipment that employs a wide wavelength range of light sources having either high frequency or time resolution and specialized detection methods. The LRF assists faculty members in these explorations by providing state-of-the-art instrumentation and a community for a collaborative exchange of ideas.

LRF Faculty Members

- **Mongi G. Bawendi**
  - **Chemistry, physics and applications of semiconductor and magnetic nanoparticles**
- **Mildred S. Dresselhaus**
  - **Carbon nanotubes, bismuth nanowires and low dimensional thermoelectricty**
- **Michael S. Feld**
  - **Cell structure and dynamics with low coherance interferometry**
- **Robert W. Field**
  - **Structural and dynamical properties of small, gas phase molecules**
- **William H. Green**
  - **Chemical kinetics, molecular simulation, free radical reactions**
- **Jing Kong**
  - **Synthesis and characterization of nanostructures**
- **Keith A. Nelson**
  - **Glass-forming liquids and glasses and outreach**
- **Andrei Tokmakoff**
  - **Molecular dynamics in solution**
- **Alexander van Oudenaarden**
  - **Noise in the expression of genes and small-scale biochemical interactions**

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Facilities Guidelines

The facilities of the LBRC, along with technical and scientific support, are made available to qualified outside researchers to pursue projects in various areas of laser biomedicine. Research projects are expected to be substantial in nature and will therefore require use of the facilities for significant periods of time. Hence, resources are normally assigned to a particular project for periods of several weeks or months, on a time-shared basis. All projects must be of a nature to be published promptly in the open literature.

Outside projects can be initiated by contacting Ramachandra Dasari, Associate Director of the Spectroscopy Laboratory. Once the scope of the project is defined, a Research Project Application must be filled out. Proposals must be concise and are evaluated by members of the LBRC's scientific staff on the basis of scientific merit, originality, potential significance and compatibility with available equipment. The review process is rapid, and applicants are promptly notified of the decisions. Participation of researchers from the small business community and from colleges, universities and hospitals, which have limited research facilities is encouraged.

Charge Policy
There is no charge for using the facilities or equipment. Costs for expendable materials are normally borne by researchers on a cost-reimbursable basis. Limited funds are available to non-MIT researchers who lack independent support.

Project Support
Each approved research project is allocated specific laboratory space and equipment for a specified period of time. A member of the staff is assigned as a liaison to each new project. If sharing of equipment and/or space is required, a schedule is worked out by the researcher and the Project Coordinator.

Reports and Publications
All researchers must keep the Director fully informed on the nature and progress of their experiments. Periodic brief progress reports and a final report must be submitted within 30 days after the project has been completed. Results of all research projects will be published in the Spectroscopy Laboratory Summary Report. Significant results should be submitted to technical journals. Acknowledgment of the use of LBRC facilities must be included in each publication. One preprint and two reprints of each publication should be sent to the Director.

Patent Rights
The primary objective of LBRC research is to produce nonpatentable research information. However, inventions may be made in the course of using the facilities. In the case of non-MIT researchers, disposition of the resulting patent rights will be determined by MIT, taking into account the public interest, the obligations to the sponsor, and the rights and equities of MIT and the inventor.

Research Project Application Form (PDF)*
***Requires Adobe Acrobat**

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Main Laboratories and Facilities Equipment

1. TISSUE CULTURE FACILITY
(NW14 1316B, Martin Hunter)

The laboratory is equipped with a -85°C freezer and a regulated 4°C refrigerator for storage of biological samples. A biological safety hood is present for sample preparation.

IEC Minotome Cryostat Tissue Microtome
Can prepare 2-200 m m thick frozen sections.

Wet Chemistry Facilities

Bio-Freezer
Temperature maintained at –85°C for biological tissue storage

Refrigerator
Temperature maintained at 4°C for biological tissue storage

Biological Safety Hood

Microscope
Olympus microscope with 5, 10, 20 and 40x objectives (transillumination)

Main Laboratories and Facilities Equipment

2. TRI-MODAL SPECTROSCOPY AND MICROSCOPY LABORATORY (NW14 1316C)

Fluorescence and reflectance spectroscopy are used to detect diseases like dysplasia (pre-cancer) and atherosclerosis in vitro and in vivo in real time. A fiber optic based portable instrument with multiple excitation wavelengths was developed to study disease characteristic changes in fluorescence and reflectance spectra. A UV-visible fluorescence microscope is used to identify tissue fluorophores. An integrating sphere system is used to determine optical properties of tissue samples.

FastEEM System 4 Units
Lambda Physik Optex XeCl Excimer Laser Pumped Dye Lasers. Pulse energy 10 mJ (308 nm), dye lasers from 340 nm – 505 nm (~2 mJ); pulse width: 10 ns. Princeton Instruments I-Max 1024 Intensified CCD with an Acton Research ARC 150 Spectra Pro spectrograph. Hamamatsu flash lamp, Computer interfaced and real time data analysis

Fluorescence Microscope
Leitz Quartz Microscope, epi-fluorescence and transmission capabilities for UV-visible light. Fluorescence excitation light source: Coherent Innova 300 Argon Ion Laser UV Power 15 Watts (lines 333.6-363.8).

Integrating Sphere System
LabSphere Integrating Sphere with 8 inch diameter and Spectralon coated interior. Andor DU420-BU CCD camera with Acton Spectra Pro 300i spectrograph. 400W Oriel light source with UV-Vis wavelength range.

Main Laboratories and Facilities Equipment

3. RAMAN BIOMEDICAL SPECTROSCOPY LABORATORY (NW14 1316D)

The Raman Biomedical Laboratory has four near-infrared Raman systems. All of the systems contain deep depletion CCDs, all are back thinned. The most versatile of these systems uses a CW Ti:sapphire laser and includes microscopic excitation. The other three systems use solid state diode lasers at 830 nm. One is used as a laboratory system for studies related to blood analyte concentrations; the other two are portable systems transported to hospitals for clinical investigations. In addition to chemical analysis of blood, studies include histochemical and morphological studies of artery and breast tissue for diagnosis of disease.

Near IR Raman and Fluorescence Mapping Microscope
Coherent Innova-90 Argon Ion Laser (power: 6W multilane visible, 1W multilane UV); CW Ti:sapphire Laser (power: 500mW, 700-1050nm); Princeton Instruments deep depletion CCD with 1024x256 pixels, sensitivity to 1000nm; Chromex 250IS spectrograph; Raman edge filter; Zeiss axioskop with phase contrast capabilities (10 and 63x objectives); dichroic beamsplitters for 352, 830, 476 nm excitation; CCD camera, monitor, and VCR for recording microscope images; computer controlled microscope stage for mapping; prism, camera lens, and sample holder for non-microscope spectroscopic measurements.

Near IR Raman Systems Using Solid State Lasers
830 nm diode lasers; Princeton Instruments deep depletion CCD with either 1024x256 pixels, 1300x400, or 1300x1300 pixels, sensitivity to 1000 nm; Kaiser Holospec spectrographs, Raman edge filters, fiber optic collection, Raman microprobe.

Big Sky Beam Diagnostic Equipment

Main Laboratories and Facilities Equipment

4. TUNABLE RAMAN FACILITY
(NW14 1326A, Ramachandra Dasari)

The CW Raman spectroscopy laboratory is a multi-user facility that contains instrumentation for visible/NIR Raman as well as UV resonance studies. Research projects in the visible Raman laboratory include the resonance Raman spectroscopy of carbon nanotubes, characterization of rhenium clusters for possible use as oxygen sensors, studies of the reaction-induced structural changes in the methane monooxygenase enzyme system, and investigation of the structural properties of left-handed Z-DNA. UV resonance Raman studies include detection of micro-organisms and their toxins, and detection of bio-aerosols on surfaces.

Visible/NIR Raman Instrument:

Coherent Innova 70-4 Argon Ion Laser
Power: 1.7W (514 nm), 1.3W (488 nm)

Coherent Innova 90-K Krypton Ion Laser
Power: 0.5W (647 nm)

Princeton Instruments Back-Thinned 1024x256 CCD

Coherent 899 ring Ti:Saphire laser
400 mW, 720-1000 nm

Coherent 699 ring dye laser
700 mW, 570-620 nm, 620-680 nm

Zeiss Axioplan
10X, 50X, 100X objectives

Bioprecision XY stage with linear endcoder

High efficiency triple monochromator with transmission gratings
Transition width 35 cm-1 at 647 nm (50% OD6), resolution 6 cm-1 at785 nm

** pending relocation to the new physical space, this facility is currently unavailable*

Main Laboratories and Facilities Equipment

5. INTERFEROMETRY LABORATORY
(NW14 1316F, Gabriel Popescu)

This laboratory is developing interferometric techniques for probing biological structures and dynamics. New methods have been developed for extending low-coherence interferometry to examine the wavelength, angular, temporal and phase shift variations of light which interacts with a biological medium.

Fourier phase microscope (FPM)
Tunnable 40 mW Ar+ laser (Melles Griot)
Programmable phase modulator (Hamamatsu Co.);
Cooled CCD (Roper Scientific)
Inverted microscope, Axiovert S 100 (Zeiss Co.)

Hilbert phase microscope (HPM)
High-power HeNe laser (Melles Griot)
Fast CCD camera (C7770, Hamamatsu Co.)
fiber optics delivery system (Oz Optics)
electronic feedback loop

Diffraction phase microscope (DPM)
Doubled Nd:YAG laser
Cooled CCD (Roper Scientific)
Inverted microscope, Axiovert 35 (Zeiss Co.)

Epi-fluorescence / phase contrast imaging system
IX71 Microscope (Olympus)
1kHz CMOS camera (Hamamatsu)

Dual-beam interferometer setup
Superlum SLD-761 superluminescent diode (center wavelength 1548 nm)
PILOT-2 diode driver
National Instruments PCI-6110 input/output board
Brimrose acousto-optic modulators (TEF-110) and drivers
Fiber and free space interferometer optics

Interference microscopy system
Olympus objective lenses
free space optical components
Photometrics CoolSnap CCD camera
Newport 850G actuators with ESP-300 controller

Superluminescent Diode Temperature Controlled Module
Power: 20 mW (1550 nm), linewidth: 20 nm.
EG&G C86064E Superluminescent Diode
Power: 5 mW (845 nm), linewidth 19 nm.

Neural electrophysiology equipment (contribution from H. Sebastian Seung)
- Warner patch clamp amplifier
- Sutter Instruments motorized electrode micropositioner
- World Precision Instruments A395 Stimulus isolator

Main Laboratories and Facilities Equipment

6. LIGHT SCATTERING SPECTROSCOPY LABORATORY
(NW14 1323, Martin Hunter)

This laboratory is developing methods for determining the architecture and structure of biological tissues using reflectance spectroscopy.

Sure Light OPO

Melles Griot He-Ne Laser
Power: 30 mW (632.8 nm), polarized.

Oriel 66181/68805 Arc Lamps
Powers 50-200W

Ocean Optics LS-1 Tungsten Halogen Lamp
Power 50 W

Princeton Instruments LN Cooled CCD-512TK - 512x512

Ocean Optics SQ2000 CCDx4
Pixel Size: 8 x 8 microns, 1024 pixels each CCD in array.
Acton Spectro-Pro 150 Dual Grating Spectrograph with Princeton Instruments IN/CCD
1024x256 Cooled Monochrome CCD
Pixel size: 24 x 24 microns.

Main Laboratories and Facilities Equipment

7. LIGHT SCATTERING SPECTROSCOPY IMAGING LABORATORY (NW14 1323, Martin Hunter)

This laboratory is developing methods for determining the architecture and structure of biological tissues using light scattering spectroscopy.

Spectra-Physics, Xenon ArcLamp
Power: 300W

Spectra-Physics, Cornerstone Monochromator

Photometrics, Sensys CCD
Pixel size: 9µm x 9µm
Pixels: 762 x 512

Photometrics, CoolSNAP HQ CCD
Pixel size: 6.5µm x 6.5µm
Pixels: 1392 x 1040

Princeton Instruments, PhotonMAX CCD
Pixel size: 16µm x 16µm
Pixels: 512 x 512

Main Laboratories and Facilities Equipment

8. OPTICAL PROBE FACILITY
(NW14 1325, Luis Galindo)

This facility is dedicated to manufacturing optical fiber probes for Raman and fluorescence spectroscopy.

SYNRAD CO2 Laser Model C48-2-115
Power: 40 W max.

FIBERTRON Multi-cureII Fiber Optic Curing Oven Model 9500 Series

LABCONCO 3' Purifier Vertical Clean Bench

BUEHLER 69-3000 Fibrmet Optical Fiber Polisher (Two Units)

LEICA StereoZoom 6 Photo Microscope with a NIKON Coolpix 950 Digital Camera

ALLIED TechcutII Slow Speed Diamond Saw

NESLAB Refrigerated Bath/Circulator Model RTE-100

ORIEL Deuterium UV Lamp Model 68840-M

OLYMPUS SZ Microscope with a Moticam 2000 CCD 2M pixels

Fluke Networks FT100 Fiber testing system

Norland UV lamp for curing

Main Laboratories and Facilities Equipment

9. PICO/FEMTO DYNAMICS
(18-085, Michael Feld)

This laboratory uses pico/femto second lasers and streak camera to obtain flourescence decaytimes of quantom dots, molucules of interests etc. The range of decay times are from 5 psec to a few nanoseconds.

Coherent Innova 400 Argon Ion Laser
Power: 12 W (all lines), 6.0 W (514 nm), 3.5 W (480 nm), 800 mW (UV).

Coherent Mira 900-P/900-F Ti:Sapphire Laser
Power: 1 W (700-1000 nm), pulse duration: 1.2 ps/200fs, repetition rate: 76 MHz.

Coherent RegA 9000Laser
Power: 500 mW (700-1000 nm), pulse duration: 200fs, repetition rate: 200 KHz.

Coherent 9400 Optical Parameter Amplifier
Power: 20 mW (600-1200 nm), pulse duration: 250fs, repetition rate: 200 MHz.

Hamamatsu C5680 Streak Camera with Imaging Software
Resolution: 2 ps

Auxiliary Laboratories and Facilities Equipment

1. PULSED VISIBLE/UV SPECTROSCOPY/ MOLECULAR DYNAMICS (6-031, Prof. Robert W. Field)

This laboratory specializes in stimulated emission pumping (SEP), laser induced fluorescence (LIF), dispersed fluorescence (DF), and surface electron ejection by laser excited metastables (SEELEM) spectroscopy of singlet and triplet states of acetylene. This facility also has the capability of performing pulsed FM laser spectroscopy.

Lambda Physik LPX 200 Excimer Laser
300mJ (308) pulse duration: 15-25 ns; rep rate: 1-100 Hz.

Lambda Physik FL 2002 Dye Laser
Pulse energy: 0.1-15mJ; tuning range: ~ 10 cm-1; bandwidth: 0.05 cm-1 (330-860 nm)

Two Lambda Physik FL 3002 Dye Lasers
Pulse energy: 0.1-15mJ; computer controlled tuning range: ~ 1 nm; bandwidth: 0.05 cm-1 (330-860 nm)

Doubling Crystals
KDP (260-360 nm); 2 BBO (215-225 nm) (used with FL2002/30003 dye lasers)

Continuum NY-61 Nd:YAG Laser
Power: 240mJ (532nm), 170(mJ 355); bandwidth: 1cm-1; pulse length: 5 ns; rep rate: 10Hz.

Continuum NY-61 Nd:YAG Laser
Power: 240mJ (532 nm), 170mJ (355 nm); bandwidth: 1cm-1; pulse length: 5 ns; rep rate: 20Hz.

Continuum Custom Injection Seeded Nd:YAG Laser
Power: 800mJ (1064 nm), 450 mJ (532 nm), 150 mJ (355 nm); bandwidth: 100 MHz; pulse length: 20 ns nearly Fourier transform limited; rep rate: 30Hz.

UV-VIS Fluorescence Spectrometer with Intensified CCD
Spex 1-meter monochromator, grating: 1200 grooves/mm blazed at 500 nm. Princeton Instruments Intensified charged coupled device (256 x 1024 pixels), sensitivity: 200-900 nm.

Coherent Innova-70 Argon Ion Laser and 899-29 CW Ti:Sapphire/Dye Laser
Power: 6W multiline visible; 899-29 1W tunable, linewidth: 1MHz.

Electro-Optic Modulator
Efficiency: 90%; driving frequency: 800 MHz.

Roper Scientific Sensys CCD Camera

Auxiliary Laboratories and Facilities Equipment

2. TIME RESOLVED SPECTROSCOPY OF NANOSTRUCTURED MATERIALS (18-085, Prof. M.G. Bawendi)

This facility is set up with contributions from the Department of Chemistry, the Center for Materials Science and Engineering and the Harrison Spectroscopy Laboratory. Its primary use is for Prof. Bawendi and his collaborators to study nano-structured materials.

LaVision Picostar HR Intensified CCD Camera used with Coherent Mode-locked Ti:Sapphire Laser
The main parts of the setup consist of (1) LaVision Picostar HR intensified CCD camera; (2) a home-built far field microscope, and (3) an imaging spectrometer. The intensified CCD camera operates at 76 MHz with a programmable opening gate of 200 - 1000 ps. The CCD intensifier consists of a cooled S25 photocathode/phosphor screen/MCP detector combination with a spectral response of 400-850 nm jitter free triggering, using a constant fraction discriminator a programmable delay in the time window of up to 20 ns with 25 ps increments. Exposure times: 100ns-1000s; Image rate: 30 frame/s; Digitization: 12bit. The personal computer with a controller card and the DaVis software (LaVision) provides data acquisition and storage.

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3. FEMTOSECOND NON-LINEAR SPECTROSCOPY OF CONDENSED PHASES (2-041, 2-009 and 2-048, Prof. A. Tokmakoff)

This laboratory uses ultrafast (<20 fs) pulses at high repetition rates from a cavity-dumped Ti:sapphire oscillator to directly measure the structure and dynamics of glasses, proteins, and complex liquids using coherent nonlinear spectroscopy. Current projects include designing and building an efficient multipass amplifier and IR OPA system to measure relaxation processes and spectral diffusion in liquid water on a ~30 fs timescale.

Spectra-Physics Millenia V
5W CW diode-pumped frequency-doubled Nd:YVO4 used to pump our Ti:sapphire oscillator

Homebuilt Cavity-dumped Oscillator
~25 nJ/pulse, variable repetition rate from single-shot to 500 kHz; ~75 nm bandwidth in the dumped pulse

Lightwave Electronics 612
Diode-pumped frequency-doubled Nd:YAG used to pump our amplifier. Variable repetition rate from 5 to 50 kHz, capable of 1.4 mJ/pulse (5 kHz) to 100 uJ/pulse (50 kHz) with extremely low noise (< 1% RMS)

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4. PICOSECOND TIME-RESOLVED SPECTROSCOPY SYSTEM (2-051, Prof. Daniel Nocera)

The Department of Chemistry and the Harrison Spectroscopy Laboratory jointly support this facility. It is used mainly by the Nocera group, to study the mechanism of electron transfer in biological systems (e.g. Cytochrome C) porphyrin-based donor-acceptor systems, and by the Swager Group, to examine the sensing mechanism of TNT sensors.

Hamamatsu C4334 Streak Scope Streak Camera System with Coherent Mode-locked Ti:Sapphire Laser

The streak camera system consists of 3 major components: (1) the streak scope camera (Hamamatsu model C4334-01), designed to take the spectral image from the spectrograph and convert it into a two-dimensional image that includes time as a second axis; (2) the imaging spectrograph (Chromex model 250is), with 3 gratings (100 lines/mm 780nm blaze; 100 lines/mm 450 blaze; 300 lines/mm 500nm blaze), which are software selectable and tunable; (3) the delay unit (Hamamatsu Model C1097-04), that allows delays of up to 32ns in steps of 30ps for use on 1, 2 and 5ns time scales. A second delay unit (Stanford Research Systems DG535) allows for delays on time scales of 10ns and higher. The camera, spectrograph and delay generators are all controlled by the program (Hamamatsu HPD-TA) on a PC. Analysis of the data is also possible using the same software package, which includes "fluorescence lifetime fitting module for HPD-TA" (Hamamatsu TA-Fit) lifetimes with a resolution of ~50ps and a window up to 1ms limited by the laser repetition rate. The streak camera is capable of measuring time-resolved emission spectra over a 100 nm wavelength range in real time. This makes direct comparison of kinetics of different spectral features possible.

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5. PULSED VISIBLE/UV SPECTROSCOPY AND COMBUSTION KINETICS (6-031, Prof. W.H. Green, Department of Chemical Engineering, and Prof. R.W. Field)

Experiments in this laboratory focus on investigating hydrocarbon radical reactions relevant in combustion processes. Radicals are generated via photolysis using either the excimer laser or the 10 Hz Nd:YAG 266 nm output. The spectra are recorded in the UV region by direct absorption (Herriott cell/Cavity RingDown Spectroscopy), where the UV is generated by the doubled output of a ND:YAG (50 Hz) pumped dye laser.

Spectra Physics Quanta-Ray GCR-3 Nd:YAG Laser
300 mJ (532 nm) 70 mJ (266 nm); pulse duration 12 ns; rep rate 1-20 Hz.

Spectra Physics 270-50 Pro Series Nd:YAG
410 mJ (532 nm) 240 mJ (355 nm); pulse duration 12 ns; rep rate 50Hz.

Lambda Physik FL 3002E Dye Laser
Pulse energy 0.1-15 mJ; computer controlled tuning range (330-860nm); bandwidth ~1cm-1 (grating) and 0.01cm-1 (etalon).

Lambda Physik Compex 102 Excimer Laser (fluorine gases)
220 mJ (248 nm); pulse duration ~20 ns; rep rate up to 20 Hz.

Leybold RUVAC WSU251 Roots Blower
Nominal pumping speed: 253 m3?h-1.

Doubling Crystals
KDP- pulse energy: 1-5 mJ (260-360nm); BBO- pulse energy 0.1-1mJ (220-340 nm).

Auxiliary Laboratories and Facilities Equipment

6. PICOSECOND LABORATORY
(6-011, Prof. K.A. Nelson)

Mechanical and diffusive properties of materials are measured by 1) interferometric imaging, and 2) impulsive stimulated thermal scattering. Current projects include characterizing the glass transition in supercooled liquids, and determining elastic moduli in high-pressure energetic materials (collaboration with the Office of Naval Research).

Spectron SL900 Mode-Locked Q-Switched Cavity-Dumped Nd:YAG Laser
Power: 800 mW (1064 nm); pulse duration: 150 ps (800 Hz)

Power Technology Inc. ML100H15 Pulsed Laser Diode
Power: 1 mW (905 nm); pulse duration: 15 ns (5 kHz)

SDL 800 CW Diode Laser
Power: 200 mW (820 nm) continuous wave

Imaging System
CCD with 256-bit Data Translations FrameGrabber, sychronized to probe laser (pulsed diode.) Images collected and averaged with Dell Optiplex.

Auxiliary Laboratories and Facilities Equipment

7. Raman Micro-Spectroscopy Facility
(13-4138, Center for Material Science and Engineering and Spectroscopy Laboratory Staff)

This facility is supported by the grants from the Center for Material Science and Engineering and the Spectroscopy Laboratory.

The Raman Micro-Spectroscopy Facility is a multi-user facility for projects involved with spectroscopic characterization of different materials. Excitation light from either an argon ion or Ti:sapphire laser is optically-coupled into a single-mode fiber and delivered to the Kaiser Hololab 5000R Raman microscope. The microscope consists of a Raman microprobe attachment, a high-quality Leica light microscope, translation stage, and video camera for image capture. Excitation wavelengths at present are limited to either 514 or 785 nm by the microprobe attachment, but other wavelengths can be added depending upon the nature of the project. The excitation spot is <3?m and the collected light is filtered by the microprobe attachment and fiber-optically delivered to the spectrograph where the complete Raman spectrum from 50 - 3500 cm-1 is collected in a single shot. Current projects include characterization of metals clusters and carbon nanotubes.

Coherent Innova 300C Argon Ion Laser
Power: 3.0W (514 nm), 7W (Multi-Line)

Coherent 890 Ti:Sapphire Laser
Power: 0.2W (785 nm)

Kaiser HoloLab 5000 Raman Microscope

Kaiser Raman Microprobe Attachments for 514 and 785 nm

Leica DMLP Microscope with Three Objectives (10X, 50X, 100X)

Wavelength and Intensity Calibration Accessory

Polarization Accessory

Kaiser f/1.8i Spectrograph
Frequency range: 50 – 3500 cm-1, spectral resolution ~5 cm-1 (785 nm)

Andor CCD
2048X 256 Pixels