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This report describes the instrumentation purchased on the DURIP grant AFOSR-89-0093 and the research work that this instrumentation will support. The objective of the grant was to acquire elements of a spontaneous Raman system for gas phase diagnostic work on currently funded combustion studies. Toward this end, we have acquired a Nd:YAG pulsed laser with frequency doubling, an optical multichannel analyzer (OMA), a computer system required to operate the OMA, and a flat flame burner for validation and testing of the Raman set-up.

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DURIP - SPONTANEOUS RAMAN SYSTEM FOR THE STUDY OF ENHANCED COMBUSTION AND NON-THERMAL PLASMAS

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Ref. No: AFOSR-89-0093 **Final Report** February 26, 1990

EQUIPMENT PURCHASED:

This report describes the instrumentation purchased on the DURIP grant AFOSR-89-0093 and the research work that this instrumentation will support. The objective of the grant was to acquire elements of a spontaneous Raman system for gas phase diagnostic work on currently funded combustion studies. Toward this end, we have acquired a Nd:YAG pulsed laser with frequency doubling, an optical multichannel analyzer (OMA), a computer system required to operate the OMA, and a flat flame burner for validation and testing of the Raman set-up. In order to purchase these items to complete a fully functional diagnostic system, we have modified and change the original equipment list found in the proposal. These changes were detailed in a letter to AFOSR dated November 1, 1988 and subsequently approved. Additionally, it was deemed necessary to have a validation test set-up for acquiring spontaneous Raman signals from hot combustion gases, thus a request was made to purchase a flat flame burner (plus gas delivery system) in a letter to AFOSR dated March 5, 1989. This request was also approved. The final detailed list of equipment purchased on this grant can be found in the following pages.

CURRENT AND FUTURE RESEARCH:

The research to be supported by this request is concerned with the study of combustion enhancement through the use of high energy electron impact processes. It is currently funded by both the National Science Foundation and the Air Force Office of Scientific Research, Aerospace Sciences, Air-breathing Combustion program (Grant No. CBT-8713328, Principal Investigator: Richard B. Peterson). At the present time a 1 kW electron beam facility has been built to inject 100 keV electrons into an atmospheric burner. The electrons leaving an the chamber pass through the reactant mixture ionizing and dissociating stable molecules and forming a reactive, dilute plasma where free radicals initiate the chain branching reaction leading to ignition. This research differs significantly from other combustion enhancing schemes in that the electrons are non-specific in their dissociating effects and because of the generation of gas phase ions. Very

little is known of the effects such a dilute, reactive plasma may have on combustible mixtures, thus the need for study. This research has potential application to the development of advanced propulsion engines for hypersonic and transatmospheric flight since combustion stabilization and control, which could result from electron injection, is crucial to this field of endeavor.

Another project which the instrumentation will support is a study of enhanced mixing at the interface between a fuel and air flow. This project is currently unfunded. It involves seeding the fuel side of the flow with an alkali metal salt to produce a conductive gas in the combustion zone of the resulting diffusion flame. Then, the application of an electromagnetic field will be use to study whether mixing at the fuel/air interface can be influenced to any extent. This project is only in its initiation phase but the instrumentation acquired by this grant will provide a means of obtaining non-intrusive temperature and major species concentrations in the experiments.

Richard B. Peterson 2/26/90

Richard B. Peterson (PI)
Dept. of Mechanical Engineering
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SPONTANEOUS RAMAN SYSTEM FOR THE STUDY OF ENHANCED COMBUSTION AND NON-THERMAL PLASMAS

Final Equipment List

	ITEM	MANUFACTURER	NOTES	AMOUNT
I.)	Nd:YAG Laser	Quantel Santa Clara, CA	1	
	Laser System Model: YG661-10		(includes shipping)	$32,300
	Doubling and Tripling Crystals Model: DS,TS		1	$5,900
	Wavelength Separator Model: WSP-2		1	$2,200
	Alignment Laser Model: 05LHR121 and 05LPL065	Melles-Griot Irvine, CA	1	$532
	Disk Calorimeter Model: 380101	Scientech Inc. Boulder, CO	1	$565
	Analog Meter Model: 37-2002	Scientech Inc. Boulder, CO	1	$760
			1	
II.)	OMA III System	PARC Princeton, NJ	1	
	Detector Model: 1455R-512HQ		1	$13,000
	Interface Card Model: 1461		1	$3,800
	Detector Module Model: 1462		1	$860
	Gate Pulse Moudule Model: 1303		1	$1,475
	Pulse Amplifier Model: 1304		1	$850
	Software Model: 1462/88		1	$1,000
	Gas Purifier System Various Items	Matheson Gas Co. Newark, CA	1	$750

SPONTANEOUS RAMAN SYSTEM FOR THE STUDY OF ENHANCED COMBUSTION AND NON-THERMAL PLASMAS

Final Equipment List (cont.)

	ITEM	MANUFACTURER	NOTES	AMOUNT
III.)	Spectrograph Model: 1231	PARC Princeton, NJ	1	$7,500
	Extra Gratings Model: 510.49-110 and Echelle-316	Instruments SA Inc. Edison, NJ (and) Acton Research Corp. Acton, MA	1	$2,725
IV.)	Optics	CVI Laser Corp. Albuquerque, NM	1	$825
	Various Items: Mounts, Bases, and Positioners	Melles-Griot Irvine, CA (and) Newport Corp. Fountain Valley, CA	1	$1,910
	Optics Table Model: XS-45	Newport Corp. Fountain Valley, CA	1	$2,015
V.)	Computer for OMA System	Zenith Data Systems Santa Fe, CA	1	
	Computer with Mouse Model: Z-386		1	$3,454
	Math Co-processor Model: 2516-80387		1	$659
	Floppy Drive & Kit Model: ZCA-14		1	$148
	GPIB Interface and Cables Model: 776207-01	National Instruments Austin, TX	1	$595
	Printer Model: DeskJet	Hewlett/Packard (purchased Locally)	1	$597
	Fortran Compiler Model: 4.1	MicroSoft (purchased locally)	1	$304

SPONTANEOUS RAMAN SYSTEM FOR THE STUDY OF ENHANCED COMBUSTION AND NON-THERMAL PLASMAS

Final Equipment List (cont.)

VI.)	Flat Flame Burner Model: SS-316/HP	McKenna Products Pittsburg, CA	2	$3,100
	Gas Delivery System Various Items	Matheson Gas Co. Newark, CA	3	$1,774
VII.)	Misc. Items (as follows) Laser Safty Goggles	Ealing Optics Inc. South Natick, MA	4	$520
	Optics and Tool Storage Cabinet Model: 9A65619N	Sears Contract Sales Salem, OR	4	$385
	Instrument Rack Model: CR-2075	Newark Electronics Eugene, OR	4	$597
			TOTAL AMOUNT:	$91,100

NOTES:

1) These items were changes from the original equipment list and were explained in a letter to AFOSR dated November 1, 1988. The requested change was subsequently approved.
2) A request was made to purchase a flat flame burner (pius gas delivery system) in a letter to AFOSR dated March 5, 1989. The request was approved.
3) The gas delivery system was actually slightly over this amount (by approximately $20). Department funds were used to make up the difference.
4) These items were deemed necessary to the proper operation of the equipment because of safety or protection considerations, or were required for the proper mounting of various electronics packages associated with the OMA system.