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Research equipment was purchased under this grant to improve New Mexico Highlands University's ability to compete for DoD research funding. The equipment was for chemical analysis and photophysics which included GC/MS, LC/MS, FTIR, single crystal X-ray diffractometer, workstation and software for quantum mechaniscal calculations and a regenerative amplifier for picosecond laser studies. work of DoD interest supported by the equipment is development of nonlinear optical materials, optical limiting and photorefractive devdices as well as environmental remediation technologies.

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Final Report

Infrastructure Enhancement for Research Grant (F49620-93-1-0581)

By Merritt C. Helvenston, New Mexico Highlands University

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Research Supported by New Equipment

Current nonlinear optics work at NMHU is part of a coalition of researches at several Universities and NASA facilities organized by chemistry professor Ronald Clark at NMHU. The program involves synthesis and characterization of donor-acceptor substituted benzenes for second harmonic generation and phthalocyanins thin films for third harmonic generation. Professors Gary Duerksen and Graham Allen in physics will perform Kurtz powder analysis.

Professor Helvenston of the Chemistry Department and the physicists will be working with charge transfer donor-acceptor complexes in polymer matrixes to study the potential for these materials to be used for optical limiting and dynamic optical refraction. This work will include picosecond time resolved studies.

Remediation studies of oxidative and reductive treatments are underway in Helvenston's group. Titania photocatalysis has been explored for remediation of dimethylnitrosamine, previously used as a rocket propellant. Also electrocatalytic reduction of chlorocarbons and nitroaromatics will be studied at both bare and surface derivitized electrodes.

All of these projects involve chemical synthesis and characterization which benefit from the improved analytical facilities (FTIR, GC-LC/MS and X-ray diffraction). The workstation and software are principally used for guidance toward optimal synthetic targets. The potentiostat is being used for the remediation studies and will be important in characterizing the electron transfer donor-acceptor complexes. The regenerative amplifier for the Nd:YAG laser will be used for time resolved studies of the donor-acceptor complexes. A more detailed description of the laser capabilities follows on page 3.

Budget Changes

Most expenditures closely mirrored projections given in the original proposal. An amendment was made to the budget effective March 4 1994 (see attached) which deleted capillary electrophoresis and total organic carbon analyzers from the original budget which were substituted for by X-ray and laser equipment. The $21,000 of laser equipment approved in the March 4 1994 amendment covered a variety of $1,000 to $4,000 items. Instead of spending $21,000 for these small items we spent $2,770 on one item and $36,000 for a major research capability for the laser lab, a regenerative amplifier (see page 3). This $17,770 increase in the laser budget was offset by unexpectedly low bids on other items. Thus the total budget was unchanged. It is worth noting that NMHU committed over $25,000 (above and beyond the $69,806 in the budget below) to upgrade the electrical provisions in the engineering building to accommodate the new laser facility.

BUDGET

EQUIPMENT	*Projected Cost*	*Actual Expend.*
HPLC-GC/MS package	$137,675	$135,750
FT-IR	$30,250	$22,552
Potentiostat system	$15,495	$12,021
Computational package (workstation + software)	$28,805	$28,281
Laser equipment	$21,000	$38,770
X-ray diffractometter	$46,000	$41,851
TOTAL	$279,225	$279,225
Department of Defence (75%)	$209,419	$209,419
Mew Mexico Highlands (25%)	$69,806	$69,806

Vendors and models

HPLC-GC/MS package:
- Mass Spectrometer: ATI Unicam AutoMass System I 120
- Gas Chromatograph: Hewlett Packard 8690 series II
- HPLC: ATI Unicam Crytal 200 (pumps) and 240 (diode array detector) and Spectra Physics ConductoMonitor III and Refractomonitor IV detectors.
- LC-MS interface: Analytica Electrospray

FT-IR: Nicolet Magna 550
Potentiostat system: Bioanalytical Systems CV-50
Computational package: SGI Indigo II XL (workstation), Gaussian 94, Spatan and Hyperchem (software).
Laser equipment: Continuum RGA60-10 regenerative amplifier
X-ray diffractometter: Enraf-Nonius CAD4

Laser Laboratory Capabilities

The Department of Physics at NMHU has purchased a picosecond regenerative laser amplifier from Continuum for use with a Quantronix 116 Nd:YAG laser. The purchase package also includes a second and third-harmonic generator and wavelength separator unit for second and third-harmonic outputs. Of the total $57,770 for the regenerative amplifier, $36,000 has been funded by the present grant, and balance of $21,250 has been covered through funding from the Science and Technology Alliance. Additional collateral contributions to the acquisition come in the form of infrastructure enhancement and essential equipment donations that directly support the use of the instrument:

208 3∅ Service Panel and Outlets for Laboratory
Quantronix 116 Mode-Locked Laser System
Neslabs HX300 Chiller
Newport RS3000 Optical Table with Isolation Legs
Full Optics (rails, mounts, stages, lenses, mirrors, spectrometer, etc.)
Fast AlGaAs Detectors
PC-Based Data-Acquisition over IEEE 488 Bus with LabVIEW Software
Associated Electronics--Digitizing Oscilloscope, Lock-In Amplifier, Pulse Generator, etc.

Integration of the laboratory facility has already begun, providing four work-study students the opportunity to participate from the ground-up in the development and research use of ultrafast high-power laser instrumentation.

The system will supply optical pulses of 50mJ/pulse at 1064 nm, 25mJ/pulse at 532 nm, and 8mJ/pulse at 355 nm at a repetition rate of 10Hz. Because of the high pulse energies, white-light continuum can also be produced by self-phase modulation in a suitable medium (such as Sapphire). Initially, the pulse duration will be approximately 50ps, as limited by the seed laser, but the system will also produce pulses with shorter than picosecond duration if pulse-compression techniques are used.

The basic capability enabled by this system is pump-probe experimentation at high pump energies with fast temporal resolution, and quasi-tunability afforded by appropriate harmonic choice and through the generation of a white-light continuum. Specifically, this includes the following standard experimental techniques:

Time-Resolved Excited-State Spectroscopy
Transient Hole Burning
Degenerate & Non-Degenerate Four-Wave Mixing
Degenerate & Non-Degenerate Two-Photon Absorption

These techniques provide information about excited-state spectra and associated lifetimes, the magnitude and relaxation time of third-order nonlinearities, diffusion times, etc.