02 INFORMATION ABOUT PRINCIPAL INVESTIGATORS/PROJECT DIRECTORS(PI/PD) and
co-PRINCIPAL INVESTIGATORS/co-PROJECT DIRECTORS

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PI/PD Name: Paul S Russo

Gender: ☒ Male ☐ Female

Ethnicity: (Choose one response) ☐ Hispanic or Latino ☐ Not Hispanic or Latino

Race:
(Select one or more)
☐ American Indian or Alaska Native
☐ Asian
☐ Black or African American
☐ Native Hawaiian or Other Pacific Islander
☒ White

Disability Status:
(Select one or more)
☐ Hearing Impairment
☐ Visual Impairment
☐ Mobility/Orthopedic Impairment
☐ Other
☒ None

Citizenship: (Choose one) ☒ U.S. Citizen ☐ Permanent Resident ☐ Other non-U.S. Citizen

Check here if you do not wish to provide any or all of the above information (excluding PI/PD name): ☒

REQUIRED: Check here if you are currently serving (or have previously served) as a PI, co-PI or PD on any federally funded project ☒

Ethnicity Definition:
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Collection of this information is authorized by the NSF Act of 1950, as amended, 42 U.S.C. 1861, et seq. Demographic data allows NSF to gauge whether our programs and other opportunities in science and technology are fairly reaching and benefiting everyone regardless of demographic category; to ensure that those in under-represented groups have the same knowledge of and access to programs and other research and educational oppurtunities; and to assess involvement of international investigators in work supported by NSF. The information may be disclosed to government contractors, experts, volunteers and researchers to complete assigned work; and to other government agencies in order to coordinate and assess programs. The information may be added to the Reviewer file and used to select potential candidates to serve as peer reviewers or advisory committee members. See Systems of Records, NSF-50, "Principal Investigator/Proposal File and Associated Records", 63 Federal Register 267 (January 5, 1998), and NSF-51, "Reviewer/Proposal File and Associated Records", 63 Federal Register 268 (January 5, 1998).

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PI/PD Name: Robert P Hammer

Gender: ☒ Male   ☐ Female

Ethnicity: (Choose one response)   ☐ Hispanic or Latino   ☒ Not Hispanic or Latino

Race:
(Select one or more)
☐ American Indian or Alaska Native
☐ Asian
☐ Black or African American
☐ Native Hawaiian or Other Pacific Islander
☒ White

Disability Status:
(Select one or more)
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PI/PD Name: Robin L McCarley

Gender: ☒ Male   ☐ Female

Ethnicity: (Choose one response)   ☐ Hispanic or Latino   ☒ Not Hispanic or Latino

Race:
(Select one or more)
☐ American Indian or Alaska Native
☐ Asian
☐ Black or African American
☐ Native Hawaiian or Other Pacific Islander
☒ White

Disability Status:
(Select one or more)
☐ Hearing Impairment
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List of Suggested Reviewers or Reviewers Not To Include (optional)

SUGGESTED REVIEWERS:
David A. Hoagland (University of Massachusetts)

REVIEWERS NOT TO INCLUDE:
Not Listed

COVER SHEET FOR PROPOSAL TO THE NATIONAL SCIENCE FOUNDATION

PROGRAM ANNOUNCEMENT/SOLICITATION NO./CLOSING DATE/if not in response to a program announcement/solicitation enter NSF 04-2	FOR NSF USE ONLY
	NSF PROPOSAL NUMBER

NSF 04-503   **01/08/04**

FOR CONSIDERATION BY NSF ORGANIZATION UNIT(S)   (Indicate the most specific unit known, i.e. program, division, etc.)

DMR - Instrumentation for Materials Research

DATE RECEIVED	NUMBER OF COPIES	DIVISION ASSIGNED	FUND CODE	DUNS# (Data Universal Numbering System)	FILE LOCATION
				075050765	

EMPLOYER IDENTIFICATION NUMBER (EIN) OR TAXPAYER IDENTIFICATION NUMBER (TIN)	SHOW PREVIOUS AWARD NO. IF THIS IS ☐ A RENEWAL ☐ AN ACCOMPLISHMENT-BASED RENEWAL	IS THIS PROPOSAL BEING SUBMITTED TO ANOTHER FEDERAL AGENCY? YES ☐ NO ☒ IF YES, LIST ACRONYM(S)
726000848		

NAME OF ORGANIZATION TO WHICH AWARD SHOULD BE MADE	ADDRESS OF AWARDEE ORGANIZATION, INCLUDING 9 DIGIT ZIP CODE
Louisiana State University & Agricultural and Mechanical College	**Louisiana State University & Agricultural and Mechanical College** **330 Thomas Boyd Hall** **Baton Rouge, LA. 70803**

AWARDEE ORGANIZATION CODE (IF KNOWN)

0020107000

NAME OF PERFORMING ORGANIZATION, IF DIFFERENT FROM ABOVE	ADDRESS OF PERFORMING ORGANIZATION, IF DIFFERENT, INCLUDING 9 DIGIT ZIP CODE

PERFORMING ORGANIZATION CODE (IF KNOWN)

IS AWARDEE ORGANIZATION (Check All That Apply) (See GPG II.C For Definitions)	☐ SMALL BUSINESS ☐ FOR-PROFIT ORGANIZATION	☐ MINORITY BUSINESS ☐ WOMAN-OWNED BUSINESS	☐ IF THIS IS A PRELIMINARY PROPOSAL THEN CHECK HERE

TITLE OF PROPOSED PROJECT **Acquisition of a Light Scattering System for Research and Education at the Polymer/Colloid Interface**

REQUESTED AMOUNT $ **171,165**	PROPOSED DURATION (1-60 MONTHS) **12** months	REQUESTED STARTING DATE **06/01/04**	SHOW RELATED PRELIMINARY PROPOSAL NO. IF APPLICABLE

CHECK APPROPRIATE BOX(ES) IF THIS PROPOSAL INCLUDES ANY OF THE ITEMS LISTED BELOW

☐ BEGINNING INVESTIGATOR (GPG I.A)
☐ DISCLOSURE OF LOBBYING ACTIVITIES (GPG II.C)
☐ PROPRIETARY & PRIVILEGED INFORMATION (GPG I.B, II.C.1.d)
☐ HISTORIC PLACES (GPG II.C.2.j)
☐ SMALL GRANT FOR EXPLOR. RESEARCH (SGER) (GPG II.D.1)
☐ VERTEBRATE ANIMALS (GPG II.D.5) IACUC App. Date _____

☐ HUMAN SUBJECTS (GPG II.D.6)
Exemption Subsection _____ or IRB App. Date _____
☐ INTERNATIONAL COOPERATIVE ACTIVITIES: COUNTRY/COUNTRIES INVOLVED
(GPG II.C.2.j)
_____
☐ HIGH RESOLUTION GRAPHICS/OTHER GRAPHICS WHERE EXACT COLOR REPRESENTATION IS REQUIRED FOR PROPER INTERPRETATION (GPG I.E.1)

PI/PD DEPARTMENT **Department of Chemistry**	PI/PD POSTAL ADDRESS
PI/PD FAX NUMBER **225-578-3458**	**Baton Rouge, LA 708031804** **United States**

NAMES (TYPED)	High Degree	Yr of Degree	Telephone Number	Electronic Mail Address
PI/PD NAME **Paul S Russo**	**Ph.D.**	**1981**	**225-578-5729**	**paul.russo@chem.lsu.edu**
CO-PI/PD **Robert P Hammer**	**PhD**	**1990**	**225-578-4025**	**rphammer@lsu.edu**
CO-PI/PD **Robin L McCarley**	**PhD**	**1990**	**225-578-3239**	**tunnel@lsu.edu**
CO-PI/PD				
CO-PI/PD				

CERTIFICATION PAGE

Certification for Authorized Organizational Representative or Individual Applicant:

By signing and submitting this proposal, the individual applicant or the authorized official of the applicant institution is: (1) certifying that statements made herein are true and complete to the best of his/her knowledge; and (2) agreeing to accept the obligation to comply with NSF award terms and conditions if an award is made as a result of this application. Further, the applicant is hereby providing certifications regarding debarment and suspension, drug-free workplace, and lobbying activities (see below), as set forth in Grant Proposal Guide (GPG), NSF 04-2. Willful provision of false information in this application and its supporting documents or in reports required under an ensuing award is a criminal offense (U. S. Code, Title 18, Section 1001).

In addition, if the applicant institution employs more than fifty persons, the authorized official of the applicant institution is certifying that the institution has implemented a written and enforced conflict of interest policy that is consistent with the provisions of Grant Policy Manual Section 510; that to the best of his/her knowledge, all financial disclosures required by that conflict of interest policy have been made; and that all identified conflicts of interest will have been satisfactorily managed, reduced or eliminated prior to the institution's expenditure of any funds under the award, in accordance with the institution's conflict of interest policy. Conflicts which cannot be satisfactorily managed, reduced or eliminated must be disclosed to NSF.

Drug Free Work Place Certification

By electronically signing the NSF Proposal Cover Sheet, the Authorized Organizational Representative or Individual Applicant is providing the Drug Free Work Place Certification contained in Appendix C of the Grant Proposal Guide.

Debarment and Suspension Certification   (If answer "yes", please provide explanation.)

Is the organization or its principals presently debarred, suspended, proposed for debarment, declared ineligible, or voluntarily excluded from covered transactions by any Federal department or agency?   Yes ☐   No ☒

By electronically signing the NSF Proposal Cover Sheet, the Authorized Organizational Representative or Individual Applicant is providing the Debarment and Suspension Certification contained in Appendix D of the Grant Proposal Guide.

Certification Regarding Lobbying

This certification is required for an award of a Federal contract, grant, or cooperative agreement exceeding $100,000 and for an award of a Federal loan or a commitment providing for the United States to insure or guarantee a loan exceeding $150,000.

Certification for Contracts, Grants, Loans and Cooperative Agreements

The undersigned certifies, to the best of his or her knowledge and belief, that:

(1) No federal appropriated funds have been paid or will be paid, by or on behalf of the undersigned, to any person for influencing or attempting to influence an officer or employee of any agency, a Member of Congress, an officer or employee of Congress, or an employee of a Member of Congress in connection with the awarding of any federal contract, the making of any Federal grant, the making of any Federal loan, the entering into of any cooperative agreement, and the extension, continuation, renewal, amendment, or modification of any Federal contract, grant, loan, or cooperative agreement.

(2) If any funds other than Federal appropriated funds have been paid or will be paid to any person for influencing or attempting to influence an officer or employee of any agency, a Member of Congress, an officer or employee of Congress, or an employee of a Member of Congress in connection with this Federal contract, grant, loan, or cooperative agreement, the undersigned shall complete and submit Standard Form-LLL, "Disclosure of Lobbying Activities," in accordance with its instructions.

(3) The undersigned shall require that the language of this certification be included in the award documents for all subawards at all tiers including subcontracts, subgrants, and contracts under grants, loans, and cooperative agreements and that all subrecipients shall certify and disclose accordingly.

This certification is a material representation of fact upon which reliance was placed when this transaction was made or entered into. Submission of this certification is a prerequisite for making or entering into this transaction imposed by section 1352, Title 31, U.S. Code. Any person who fails to file the required certification shall be subject to a civil penalty of not less than $10,000 and not more than $100,000 for each such failure.

AUTHORIZED ORGANIZATIONAL REPRESENTATIVE	SIGNATURE	DATE
NAME		

TELEPHONE NUMBER	ELECTRONIC MAIL ADDRESS	FAX NUMBER

*SUBMISSION OF SOCIAL SECURITY NUMBERS IS VOLUNTARY AND WILL NOT AFFECT THE ORGANIZATION'S ELIGIBILITY FOR AN AWARD. HOWEVER, THEY ARE AN INTEGRAL PART OF THE INFORMATION SYSTEM AND ASSIST IN PROCESSING THE PROPOSAL. SSN SOLICITED UNDER NSF ACT OF 1950, AS AMENDED.

2. Project Summary

Instrumentation to measure the size, size distribution, charge, stability, and self-assembly of materials at the polymer-colloid interface will advance existing research projects and training at Louisiana State University. For the first time at that institution, it will be possible to measure zeta potential, which is related to the effective charge on a molecule or particle in solution. This will: provide clues to the mechanism by which optically useful colloidal crystalline arrays form in suspensions of novel silica-polypeptide composite particles; enhance understanding of oligopeptides designed to inhibit the formation of amyloid plaques thought to be responsible for Alzheimer's disease; and, permit a detailed study of dendrimer-based nanoparticles designed to trap and release contaminants and other molecules on command. Of a routine nature, the zeta potential apparatus also permits biophysical measurements such as the isoelectric point of proteins and subtle changes in their size under biologically relevant conditions. An asymmetric field flow fractionation device with on-line scattering detector is also requested. It will permit high-resolution measurements of the size distribution of particles and assemblies too large for gel permeation chromatography and other conventional methods. The size distribution is an important consideration in some of the projects already mentioned. Other areas that will benefit include polyelectrolyte properties of polysaccharides, virus preparation and function, nanoparticles designed for high-speed imprinting/sensor applications, and novel cylindrical or cone-shaped vesicles with a variety of materials science applications. The new equipment will permit an older device to be "retired" and then reborn in the hands of student designers. The outcome will be a device that transcends commercially available equipment for certain applications, including microrheology and rapid self-assembly.

The diverse groups of the primary investigators number some 30 graduate students, undergraduate students and postdoctoral fellows. They host undergraduate interns through an NSF-REU site and other summer programs that have been highly successful when it comes to attracting under-represented groups and enhancing their interest in science. Other beneficiaries will be about 15 students annually (including entering NSF-IGERT fellows, all of them US Citizens) who enroll in the core Macromolecular Studies curriculum at Louisiana State University. Interdisciplinary, team-taught courses feature laboratory exercises and challenges that will place the requested research equipment in student hands. Best-practice information and tutorials will be placed on the internet. The new acquisitions will join existing instruments in a polymer analysis laboratory that has a tradition of collaboration with industrial partners and other universities. Very few asymmetric field flow fractionation units with on-line detectors are available in publicly accessible laboratories in the United States, and none in the south-central industrial corridor. The student designers of instrument to be reborn will receive challenging, hands-on training in optics, electronics and computer interfacing applicable to many areas of science and technology.

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For font size and page formatting specifications, see GPG section II.C.

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References Cited	2	
Biographical Sketches (Not to exceed 2 pages each)	6	
Budget (Plus up to 3 pages of budget justification)	3	
Current and Pending Support	5	
Facilities, Equipment and Other Resources	3	
Special Information/Supplementary Documentation	13	
Appendix (List below.) **(Include only if allowed by a specific program announcement/ solicitation or if approved in advance by the appropriate NSF Assistant Director or designee)**		

Appendix Items:

*Proposers may select any numbering mechanism for the proposal. The entire proposal however, must be paginated. Complete both columns only if the proposal is numbered consecutively.

4. Project Description (including Results from Prior NSF Support)

Common Abbreviations
- AFFF = Asymmetric Field-Flow Fractionation
- DLS/SLS = Dynamic/Static Light Scattering
- GPC/MALLS = Gel Permeation Chromatography/Multiple Angle Laser Light Scattering
- PALS = Phase Analysis Light Scattering
- QELS/EOS = Wyatt translation of DLS/SLS

4.1 *Technical description of the proposed system.* The proposed acquisitions form an integrated system that will support and expand existing research. Each component works together and with existing equipment to characterize charge, stability, size, aggregation and size distribution. The three components appear in order of need, but all are important.

Component 1: Malvern ZetaSizer ZS

The Malvern ZetaSizer ZS measures the zeta potential, ζ, of suspended colloidal particles, polymers and aggregates. Using the latest phase analysis light scattering (PALS) principles, it provides a great advance over earlier electrophoretic light scattering tools. Aqueous systems are studied using disposable plastic cells to minimize electrode fouling, while organic solvents require an adapter for standard glass cells. The ZetaSizer also offers high-throughput dynamic light scattering (DLS) at a single scattering angle. This requires that new samples be validated on an existing, multiangle DLS instrument (see below). Thereafter, the ZetaSizer ZS will accelerate the study of size with temperature, pH and salt, especially valuable in self-assembling systems. The ZetaSizer ZS uses a focusing mechanism and fiber optic detection in a near-backscatter arrangement, thus enabling measurements in turbid suspensions.[1] For small and uniform scatterers, where the single scattering angle and polydispersity are not issues, the device can also provide absolute molecular weights and virial coefficients. Size distributions can be estimated, but with very low resolution compared to Component 2.

Component 2: Wyatt Asymmetric Field Flow Fractionation (AFFF)

The Wyatt AFFF is a turnkey system capable of separating polymers and colloids by size, with on-line detection of concentration and molecular parameters such molar mass, M, hydrodynamic radius, R_h, and, under favorable circumstances, radius of gyration, R_g, and particle form factor, $P(q)$. Its close cousin is gel permeation chromatography with multiple-angle light laser scattering detection, GPC/MALLS. AFFF surpasses GPC for large particles. The AFFF system includes a superior MALLS instrument (the EOS) which will replace one of those installed on our GPC/MALLS devices (see below). It also includes a single-angle DLS detector (the QELS) that may be applied equally to GPC/MALLS or AFFF. The AFFF can run with nonaqueous or aqueous samples. Pumps, degassers and autoinjector are included. One must order the "high temperature" option to achieve any temperature control at all.

Component 3. Viscotek GPC Max

A new autoinjector/pump/degassing unit is requested for an existing GPC/MALLS system. It will replace a 1970's era pump and expensive, wasteful helium sparging.

4.2 *Existing Equipment.* There is no capability at LSU for zeta potential measurement or field flow separations, but the requested instruments would join a light scattering device built in 1985

with the PI's only previous NSF-DMR equipment request. A new Correlator.Com correlator is being tested as a possible replacement for the ALV5000 that arrived in 1992. By any measure save ease of use, this device is still a competitive instrument. A secondary objective of this proposal is to liberate it for the originally intended physical research (example: depolarized dynamic light scattering[2,3,4]). Even as they provide new capabilities, the requested, easy-to-use instruments can assume most of the characterization chores of a growing polymer/colloid effort that now numbers some 30 full-time students and postdocs (compared to about 8 in 1985).

Soon after a Wyatt DAWN GPC/MALLS was obtained in 1992, a second DAWN of similar vintage was rescued from LSU's Audubon Sugar Institute. These were miserable instruments (noisy, low-resolution A/D converters, illogical software) until upgrades about six years ago. The difference is amazing, but their sensitivity remains about half that of the EOS supplied with the AFFF. One DAWN serves users with aqueous samples and the other handles nonaqueous systems. Both have a teaching mission. Students in our Macromolecular Systems II integrated lab-lecture course learn every step of alignment, calibration, normalization and data analysis. These aging instruments provide almost every polymer molecular weight at LSU. One will be retired from daily service if this proposal is funded (to be recycled in a student training project; see Sec. 4.8). The pumps are tired after several rebuilds and pulsate more than the requested computer-controlled pumps. The aqueous system uses a differential refractive index concentration detector from the 1970's; its drifty incandescent light source requires frequent calibrations. Its poor sensitivity requires injection of some samples at too high a concentration for optimum separation and MALLS measurements. Neither instrument has an autosampler, so much time is spent cleaning manual injectors and running stairs for injections on the half-hour. Autoinjectors (one supplied with the AFFF, another requested as Component 3) will improve throughput, encourage extra repeat runs, and minimize wear from fast pump idling.

We recently inherited a broken Coulter Model 440SX DELSA apparatus. Coulter offers to restore it for about $6000. We have not pursued this option, because converts to the new PALS instruments (including the donor of the 440SX) report much better results with less trouble. Improved cell design and automated location of the stationary plane to null the electro-osmotic effects account for the efficiency.

4.3 *Principals of Measurement.*

4.3.1 *Batch vs. Separation.* Samples loaded manually into a cell are said to be measured in batch mode. Only limited information can be obtained about the size range (e.g., via Laplace inversion of DLS data) but batch measurements prove valuable to study average size and changes thereof. A sample whose solute molecules are in electrophoretic motion is also considered a batch sample. Time-stable samples should be separated before study. The classic method for doing so, GPC, is most effective when coupled to a physical detector, light scattering and viscosity being the most popular. A time-aligned concentration sensor is also required. Field Flow Fractionation (FFF) competes with GPC over much of its range,[5;6] and works better for large solutes. In classical FFF, the solute flows down a shallow channel sandwiched between two porous membranes. A cross-flow through the membranes holds larger solutes near the bottom (collection) layer, where the channel flow is slow. If the cross flow is not overwhelming, smaller particles diffuse their way up to the faster flowing layers within the channel. The order of elution is opposite to GPC: in AFFF, small particles normally elute first. In Asymmetric FFF (AFFF) the upper membrane is replaced by a clear observation window.[7] Some of the channel flow is prevented from exiting the channel to create a cross flow. The injected sample is focused

towards a thin band by opposing channel flows. A detailed separation theory describes how that band disperses as it flows down the channel. This has enabled successful determinations of transport coefficients and other information.[7] Like GPC, AFFF benefits greatly from on-line physical detection of the nearly monodisperse particles eluting from the column.

4.3.2. *Light Scattering Basics.* The requested components rely on light scattering. The Rayleigh factor, $\mathcal{R}(\theta)$ describes the intensity, I_s, of light scattered to a detector at angle, θ, and distance, r, normalized by the scattering volume, V: $\mathcal{R}(\theta) = r^2 I_s/VI_o$, where I_o is the incident light intensity. The scattered field represents the instantaneous strength of a Fourier component of concentration in a direction q, which bisects the incident and detected rays. The particular Fourier component detected has spatial frequency $q = |\underline{q}| = 4\pi n \cdot \sin(\theta/2)/\lambda_o$ (n = refractive index, λ_o = wavelength of light *in vacuo*, θ = scattering angle). Since it represents spontaneous concentration fluctuations, scattered light is a thermodynamic property. As with osmotic pressure, Π, scattering can provide molecular information. Indeed, the scattering is inversely related to $(\partial\Pi/\partial c)_T$ where c is the solute concentration.[8;9] A convenient form of the scattering intensity, valid for the dilute solutions the requested instruments are designed to handle, reads: $Kc/\mathcal{R}(q) = 1/(MP(q)) + 2A_2c +$ higher terms. Here, K is an optical constant usually assumed (incurring a small error) to be independent of the molecular weight, M. The particle form factor, $P(q)$, where $0 \leq P(q) \leq 1$, may reveal something about particle shape and size. The osmotic second virial coefficient, A_2, describes interactions between particles. In the low-angle limit $q \rightarrow 0$, $P(q) = 1$. Then extrapolation to $c = 0$ (or operating at low c with A_2 known) gives the molecular weight, M. Multiple angle measurements permit $P(q)$ to be converted to R_g via $P(q) \approx 1 - q^2 R_g^2/3$, independent of particle shape for $qR_g < 1$. It is sometimes impractical (or unwise) to make measurements at sufficiently low qR_g, in which case $P(q)$ can be evaluated for an assumed shape to obtain size.

4.3.3. *Dynamic light scattering.* If a scattering signal collected under conditions of spatial coherence is decimated into small increments of time, it will be seen to fluctuate. The fluctuations reflect particle motion, creating the basis for DLS. The intensity autocorrelation function $<I_s(0) \cdot I_s(t)>$, where t is the lag time separating two intensity measurements, can be approximated by a correlator with an accuracy that depends partly on the acquisition time. In a stationary system, the intensity fluctuations represent the variations in amplitude of a particular Fourier component of concentration at spatial frequency q. The correlation function reflects the relaxation of these inhomogeneities according to a diffusion law for periodic boundary conditions,[10] which is to say that it decays exponentially: $<I_s(0) \cdot I_s(t)> = 1 + f \cdot e^{-2Dq^2 t}$ where f is an instrumental parameter representing optical coherence, the strength of the scattered signal relative to scattering from solvent and detector dark signal. D is the (mutual) diffusion coefficient, which approximates the self diffusion coefficient at the concentrations for which the requested devices are intended. The hydrodynamic radius is defined as $R_h=kT/(6\pi\eta_o D)$ where k is Boltzmann's constant, T the absolute temperature and η_o the solvent viscosity.

4.3.2. *Uniform motion.* If the scatterers are not stationary, but instead undergo uniform motion in response to an applied electric field (requested Component 1) or flow (requested Component 2), the correlation function contains an extra term representing the transit time across the detected volume.[10] This is only significant if the normal relaxation by diffusion is incomplete on the scale of the transit time. DLS works well in systems that are not moving too fast. An exception—and also an opportunity—arises when the light striking the detector is not entirely from the scattered light but contains a small "local oscillator" component derived

directly from the laser source. Then the signal from the uniformly moving particles of velocity $\underline{v}$ combines with the local oscillator to produce a damped cosine autocorrelation function. The "ringing" frequency is $\underline{q}\cdot\underline{v}$; since $\underline{q}$ is known, this can be used to measure the velocity and, knowing the applied field, the electrophoretic mobility μ. This is the basis for classical laser Doppler electrophoresis.[10;11] In a medium of dielectric constant, ε, the zeta potential is obtained by solving:

$$\mu = \zeta\varepsilon\cdot F(\kappa a)/\eta \qquad (1)$$

where $F(\kappa a)$ is a function of the Debye parameter, κ, and $a \approx R_h$. The function $F(\kappa a)$ is evaluated numerically but tends to range from 1 for nonpolar solvents to 1.5 for sufficiently large particles in aqueous suspensions. The zeta potential reflects the charge on the particles or polymer, less any strongly bound counterions.[12]

      4.3.4 *Embodiment of principles in the requested instruments.* In the AFFF instrument, one does not want any stray light, which could serve as a local oscillator, so that post-separation DLS can be conducted in the flow cell. Together with the multi-angle intensity detectors, this provides an opportunity to measure both R_h and R_g. When the two can be measured in the same range, their ratio provides information about shape.[13] When they cannot, shape may yet be inferred from the trend of size *vs*. mass if the system is polydisperse. Changes in the size *vs*. mass trend may indicate branching, to use an example that is relevant to the formation of amyloid aggregates. In the requested ZetaSizer, a local oscillator is deliberately created, but the measurement principle is more complicated than classical laser Doppler electrophoresis. The problem with that approach is that the scatterers must move a distance comparable to $2\pi q^{-1}$, typically many particle diameters. Such large-scale motions require long application of high voltages in nonaqueous suspensions of weakly charged particles and cause deleterious ohmic heating in salty aqueous solutions. About a decade ago, an alternative to classical laser Doppler electrophoresis was devised. Phase analysis light scattering[14;15] follows the time evolution of the phase of the scattered light compared to the local oscillator reference. The phase evolution signal is sensitive to electrophoretic motion, and can be determined rapidly without long-range motion or the high electric fields needed to induce it. In PALS, the electrical field may be applied at comparatively high frequencies (hundreds of Hz). The requested Malvern instrument applies a range of frequencies to determine the distribution of ζ. The sensitivity of PALS exceeds that of classic laser Doppler electrophoresis by up to 1000.[15]

4.4 *Measurement Practice.* "HowTo" guides posted on the LSU Macromolecular Studies Group website (http://macro.LSU.edu/HowTo) describe scattering practice and the important advances due to flow cells. Following a chromatography column, as in GPC/MALLS or AFFF, a flow cell stays clean for a very long time, which eliminates tedious "dedusting." As nearly uniform particles elute, they can be registered efficiently by MALLS and DLS. The intensity shifts that occur in batch LS measurements when a new cell is inserted for each sample, the solvent and the Rayleigh standard disappear in flow operation. The old requirement for measuring particle size $(R_g > \lambda_o/20)$ has been relaxed to $R_g > \lambda_o/50$: measurements down to 12 nm are routine using inexpensive red lasers. Even smaller polymers can be studied by GPC/intrinsic viscosity, but this method is less effective for globular particles (proteins, latex particles), dendrimers and heavily branched macromolecules. Very small sizes can now be accessed by flow DLS. The results are stunning. At the Spring 2003 ACS Meeting, DuPont's Dr. Patricia Cotts showed quiet DLS correlograms obtained during flow with the requested Wyatt QELS. Her sample was a

polystyrene of M=3,600 g·mol^{-1}, 0.3% with 1-s acquisition time, in tetrahydrofuran. We can duplicate this measurement on our conventional batch DLS apparatus using a focused pinhole collimation to detect a very small volume, but it requires a large and expensive laser. We can also duplicate it with single mode fiber optic detection, which is how the Wyatt QELS does it. The fiber optic advantage is that a large volume remains optically coherent, enabling use of a weak laser well matched to its detector. In batch mode, this is less of an advantage than it may seem at first, because then a large volume must remain free of dust for the duration of the measurement. For solvent cleaned by the GPC columns, or even the filter following an AFFF channel, it is perfect. The lesson is clear: flow cells greatly simplify polymer *analysis* chores in stable samples.

Flow cells would often be a nuisance for studies of *physical* changes, especially kinetics of aggregation or self-assembly. When not serving up zeta potentials, the requested ZetaSizer can accomplish many such batch measurement duties. *It requires validation first!* The simple DLS theory presented in Sec. 4.3 did not allow for effects of polydispersity or and shape anisotropy. **Figure 1** shows DLS results for two LSU samples. In human influenza virus, the apparent R_h depends on scattering angle. Size polydispersity is at fault. This sample could not be measured accurately on the ZetaSizer, although trends might be followed qualitatively. The silica-polypeptide composite particles can be measured well because they are so uniform. Once a sample is validated for single-angle DLS, or at least the magnitude of potential errors known, the ZetaSizer will outrun our existing instrument when it comes to studying trends. Temperature cycles can be programmed and pH or salt varied using the autotitrator. The ZetaSizer is not immune to dust, but it does feature good post-measurement discrimination (not as sophisticated as our own[16;17]). We would not be interested in the ZetaSizer as a stand-alone DLS instrument, but for samples validated by multiple angle measurements, and experiments where trends are more important than absolute accuracy, it will be very effective.
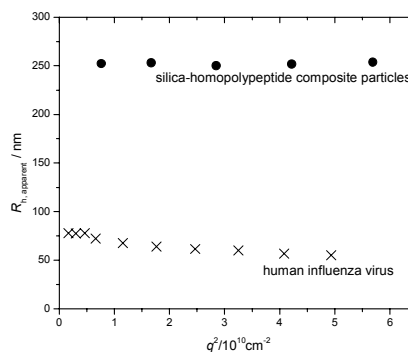
Figure 1. Influenza should not be measured on the NanoSizer. Synthetic particles are OK.

4.5 *Equipment Selection*. The selection is based on direct experience. The aforementioned Dr. Patricia Cotts serves as an external committee member for NSF-IGERT fellow Jason Campbell, a fourth year graduate student who visited her lab at DuPont, taking typical samples for his research and some others from planned users. This permitted him to try the AFFF unit in an actual setting. He reports that the unit has an interface similar to our existing GPC/MALLS, was easy to operate and learn, and that separations were good for the porous, molecular recognition nanoparticles of his dissertation research. Competing instruments from PostNova lack the multiple-angle light scattering detection and QELS capabilities. One could assemble an AFFF system from PostNova components, a Wyatt or Brookhaven multiangle instrument, a Precision Detectors or Viscotek DLS or even a home-brew fiber optic DLS. Although construction provides valuable training, it should lead to something that extends the frontier of possibilities. This would not. Sec. 4.8 describes an *appropriate* training project.

Preference for the Malvern ZetaSizer may represent just that we had it on loan for almost two weeks to conduct preliminary measurements on a wide variety of samples. This is long enough for us to pop the cover off to see what makes it tick; Malvern partner ALV followed many of the literature prescriptions for good DLS performance in a fiber optic, backscatter alignment.[1;18-20] Zeta potential measurements are made at low scattering angles to keep diffusional broadening minimized. Rough handling during shipping did not misalign the reference beam. The software permits access to raw data in most cases. We attempted to compare a Brookhaven ZetaPALS at another university, but the cell was fouled and the visit was too short. Before finalizing our purchase, we will test a working Brookhaven ZetaPALS, but two Brookhaven instruments (still comparably priced) are required because that vendor's solution to the study of turbid suspensions is a separate instrument, the FOQELS. It is also possible that Coulter will finally replace the 440SX DELSA; we have learned that a batch of four DELSA's produced last April may be the last (another reason not to repair the inherited DELSA).

4.6 *Major Research Descriptions*
4.6.1 Paul S. Russo, Professor of Chemistry. *Hierarchically structured silica-polypeptide composite colloidal particles.*
Overview. With support from NSF-DMR #0075810 (2000-2005) we are synthesizing composite particles based on a silica core and covalently attached homopolypeptide shell that provides chirality, a configurable surface through the helix-coil transition, and the opportunity to produce responsive polycolloids with discrete sizes.[21-23] In a new variation, a poly(carbobenzoxy-L-lysine) shell (100 nm) surrounds a silica core (200 nm) that, in turn, encapsulates superparamagnetic cobalt (5-10 nm). **Figure 2A** shows the whole particles and **Figure 2B** the Co/SiO_2 core. In an applied magnetic field, the particles chain together as in **Figure 2C**. The chains disassemble by Brownian motion when the magnetic field is removed, proving magnetic reversibility. Two strategies are being pursued to make permanent polycolloid chains. In the first, **Figure 2B**, an extra coating of silica will be condensed to "glue" Co/SiO_2 cores chained together by an applied field. These "discretized" colloidal chains will be coated with polypeptides using our published chemistry.[21] In a second approach, spherical Co/SiO_2 particles will be coated with polypeptides first. After chaining by an applied field, they will be linked through metathesis reactions that take advantage of alkenes designed into amino acid sidechains at the outer periphery of the shell. It has been demonstrated that the polypeptide shell consists of living polymers so that alkenyl amino acids can be added. A Grubbs-catalyzed metathesis crosslinking reaction has also been demonstrated on linear polypeptides containing the desired alkene groups. The resulting polycolloid chains may be of use in direct observation of chain dynamics, extensional flow, or other microrheological experiments. Helix-coil transitions may be able to expand and contract chains produced by the second approach, with corresponding variations in optical and viscoelastic properties. Much effort has gone into controlling the surface density of the polypeptide shell, because dense shells do not undergo a helix-coil transition. **Figure 2D** shows lightly coated particles that expand and contract with temperature. They also assemble slowly by gravity into colloidal crystalline arrays, a process that may be hastened in a magnetic field. Single domains of these materials, held between crossed polarizers, act as light filters with a color purity similar to that of interference devices.[23] It is hoped that the helix-coil transition can provide a basis for self-annealing to produce colloidal crystalline arrays with larger domains, reminiscent of particles based on other responsive polymers.[24]

Figure 2A. Poly(carbobenzoxy-L-lysine) shell-SiO_2 core Composite Particles. Scanning electron microscopy image.

Figure 2B. Silica-Cobalt Particles (left) can coesist with silica-coated chains (right).

Figure 2C. Chain of particles (approx 0.4 μm) under applied magnetic field. Differential interference contrast image.

Figure 2D. Size variation with temperature
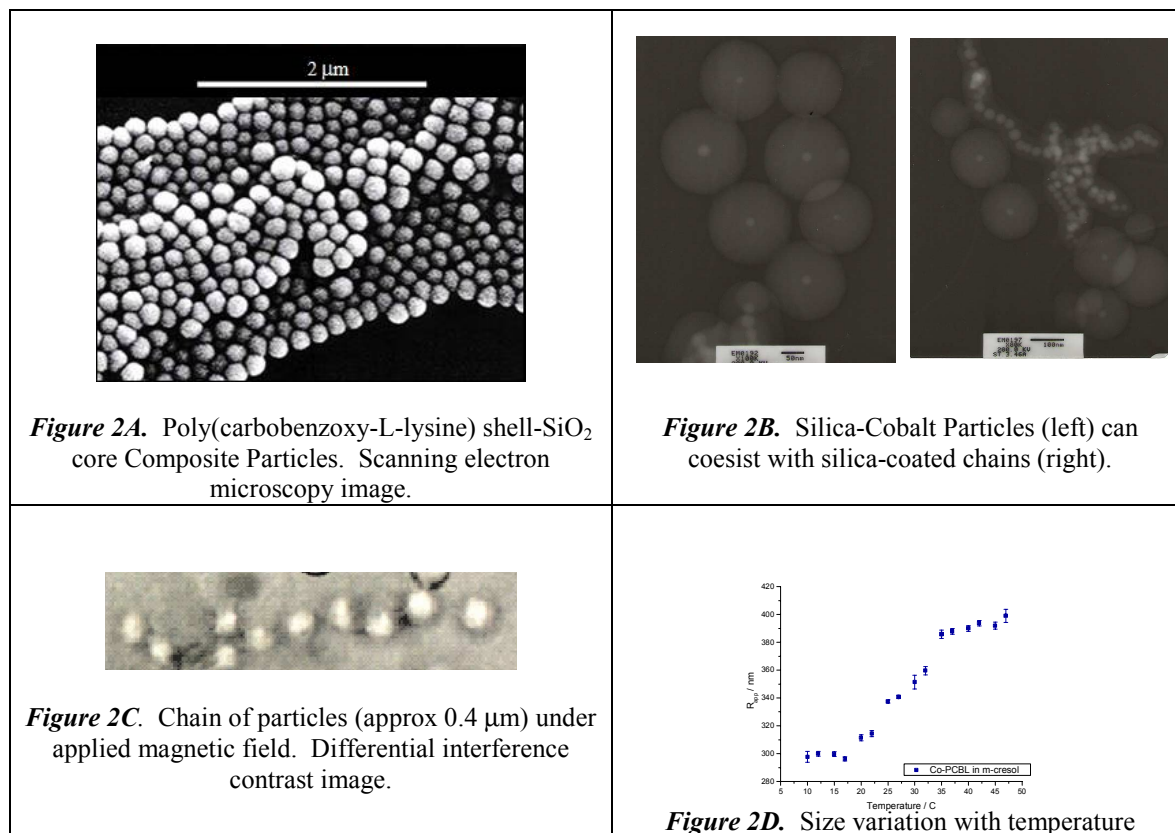
Need. LSU lacks any equipment to measure charge on particles. We share with manuscript reviewers a curiosity about the role of possible residual charges in stabilizing colloidal crystalline arrays, preventing the particles from chaining efficiently under applied magnetic field, etc. The charge issue so easily addressed by the requested ZetaSizer will become even more crucial as we move ahead to sidechain deprotected polypeptide shells and aqueous suspensions. DLS provides only limited information about size uniformity. Laplace inversion routines, such as CONTIN, are inferior to DLS coupled to separation methods, AFFF being the best choice for these large particles. These particles exhibit only weakly nonexponential correlograms, but they are *not* uniform. This probably matters to colloidal crystal quality, and it certainly matters to our attempts to chain the particles into discretely sized polycolloids. Sloping R_h vs. q^2 plots, as in **Figure 1** for influenza virus, are sometimes found for the synthetic particles. That indicates a problem, but says little about its severity, requiring laborious, expensive and slow electron microscopy experiments in the absence of the requested AFFF. Microscopy suffers well-known limitations regarding the number of particles sampled and artifacts during sample preparation (the EM size for our particles is invariably smaller than the DLS size, suggesting the shells shrink on drying). Trends in temperature can be studied with the existing DLS apparatus, but these slow, labor intensive experiments interfere with other studies requiring special alignments (example: rotational diffusion of these same particles in suspensions of polypeptide rods). Once the particles are validated, trends will measured on the ZetaSizer.

Impact. We will be able to study temperature and pH trends faster. Synthetic variations can be evaluated faster, essential if we are ever to supply large quantities of these particles to groups that have expressed interest (a sperm bank, an anticancer group, and a photonics bandgap/liquid
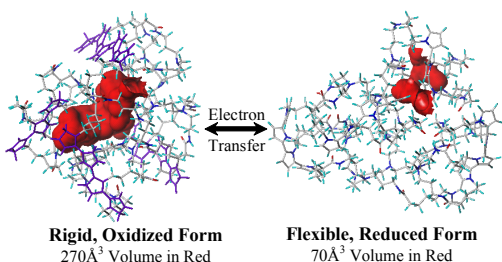
crystal team). We also require larger samples for our own use (it is even hard to measure concentrations now). We will better characterize size distributions and finally be able to assess residual charge. Students benefit by gaining new skills in FFF and zeta potential measurement.

Appropriateness of equipment. Once particles are validated on the conventional DLS, meaning that a plot like that in **Figure 1** is flat, there is no doubt the requested ZetaSizer can do the job. Data like those of **Figure 2D** were automatically and efficiently collected during an on-site demo. We may be the first group to use the Wyatt AFFF in solvents such as pyridine and *N,N'*-dimethylformamide; however, it performs well in tetrahydrofuran, so we are optimistic.
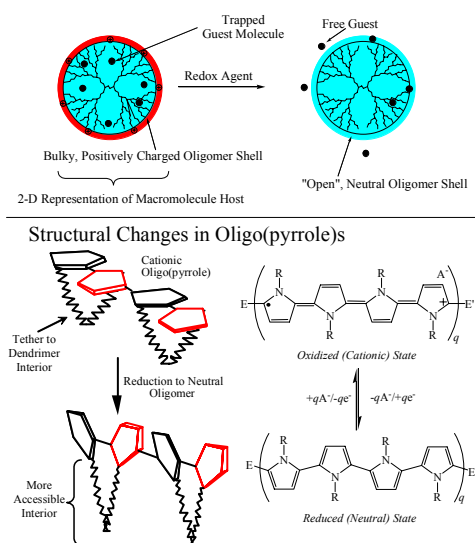
4.6.2 Robin McCarley Professor of Chemistry. *Stabilized Molecular Assemblies – Stimuli-responsive Dendrimer Host Systems.*

Overview. With support from NSF-CHE#0108961 (2001-2004), we are fabricating dendrimer host systems whose hosting capabilities are manipulated through application of stimuli. Electron-transfer-responsive (redox) hosts based on oligo(pyrrole)-terminated poly(propylene imine) dendrimers are being explored due to their ability to retain small molecule guests when the oligo(pyrrole) termini are in the oxidized state and readily release the small molecule guests when the oligo(pyrrole) termini are in the reduced state, **Figure 3**. The changes in the planarity of the oligo(pyrrole) termini upon switching of their oxidation state result in structural changes to the PPI dendrimer interior, as noted in molecular modeling studies, **Figure 4**, and as evidenced by the change in the release of small molecule guests, **Figure 5**.

Optimization of the trapping efficiency of the POPTDs requires optimization of the oligomerization reaction conditions for the pristine or monomeric PTDs.

Figure 3. Upper: pictorial depiction of small molecule release from the planar, oligomeric pyrrole-terminated dendrimer (POPTD) upon its reduction to the neutral, oligomeric PTD (NOPTD) state. Lower: the associated structural changes in the oligo(pyrrole) groups at the PPI periphery when moving from the POPTD state to that of the NOPTD.

The number of pyrrole monomer repeats in the oligomer chains at the dendrimer periphery and the hosting properties of the POPTDs will be affected by the proximity of the monomers to each other in the *monomeric* PTD, which is a function of the pH and ionic strength of the medium.

Rigid, Oxidized Form
270Å³ Volume in Red

Flexible, Reduced Form
70Å³ Volume in Red

Figure 4. Energy-minimized structures of the POPTD and NOPTD states of the oligo(pyrrole)-terminated dendrimers. Connolly Channel Plots shown in red indicate that the free space available to guests is drastically reduced in the NOPTD state, agreeing with guest release data in Figure 5.

Figure 5. Kinetic release profiles for Nile Red from the various PTDs in pH 7.0 (phosphate) buffered water.

Solution NMR relaxation studies point to a fairly significant impact of pH on the "floppiness" of the pyrrole termini for the *monomeric* PTDs (due to the tertiary amine interior of the PPI core), which in turn indicates significant structural changes in the dendrimer. Also, preliminary NOESY and ROESY NMR experiments lead to the conclusion that backfolding of the periphery monomer groups into the PTD interior is not significant at low pH. Ionic strength impacts are being studied, as are the cumulative effects of pH and ionic strength on the oligomerization reaction (studied by IR and MS) and the hosting properties of the POPTDs.

Need. LSU lacks any equipment to measure charge on particles, and our need to measure both PTD charge and size as a function of solution conditions is great. It is very important that we be able to assess the charge on the monomeric PTDs and their size, and correlate this information with that from the NMR studies so that a model can be constructed for the monomeric PTDs and relate that to the resulting hosting and release properties of the POPTDs/NOPTDs. Deployment of successful dendrimer strategies on colloidal particles is a future step in this research, and that will benefit from the requested AFFF.

Impact. We will be able to construct a model for the POPTD precursor, and more importantly, be able to more quickly optimize the conditions needed to obtain highly efficient hosting of guests, particularly when we investigate the effects of tether length between the pyrrole groups and the PTD on the hosting capabilities.

Appropriateness of equipment. There is no question that the requested ZetaSizer can make electrophoretic charge measurements for particles in this size range.

4.6.3 Robert P. Hammer, Professor of Chemistry. *Synthesis and Analysis of Inhibitors of β–Amyloid Protein Aggregation*

Overview: With support from NIH AG17983 and NSF-IGERT DGE-9987603 (both 2000-2005) we are developing inhibitors of amyloid formation and evaluating their efficacy as suppressors of toxicity and therapeutic agents for amyloid-associated illnesses such as Alzheimer's disease. An integral part of this research is developing new and evaluating existing tools for characterizing the aggregation states of amyloidogenic proteins. This is particularly challenging because the aggregates range from nanoscopic oligomers (M ~ thousands) to microscopic fibrils (M ~ billions). The central scientific hypothesis is that peptide analogs which mimic the "hydrophobic core" of β-amyloid protein, but have only one edge available for hydrogen bonding, may inhibit β-sheet oligomerization and the resulting fibrils that form the major component of amyloid plaques found in the brains of patients with Alzheimer's disease.[25;26]

We have achieved the "blocked edge" design by using our inhibitors with alternating natural L-amino acids and α,α-disubstituted amino acids (ααAAs) having side-chains larger than methyl (propyl, isopropyl, isobutyl, benzyl, etc.), which are known to favor extended, sheet-like, conformations.[27;28] A key aspect of these structures (**1**) is that they can only form hydrogen bonds from one edge of the β-strand, as one face is blocked by the *pro-R* alkyl group of the ααAAs. As shown in **Figure 6**, use of the alternating ααAA design provides a sheet structure in which the exo-hydrogens are replaced with large alkyl groups, making further hydrogen bond β-sheet assembly impossible.

Our amyloid "blocker" molecules are modeled after those of Murphy and co-workers [29] in which we use the alternating design of ααAAs/normal L-amino acids corresponding to the hydrophobic core of β-amyloid and a solubilizing oligo-lysine tail (**2, Figure 7**). This peptide contains the ααAAs dibenzylglycine (Dbg) and diisobutylglycine (Dibg), both of which are difficult to prepare[25] and very difficult to incorporate into peptides.[30] We have achieved
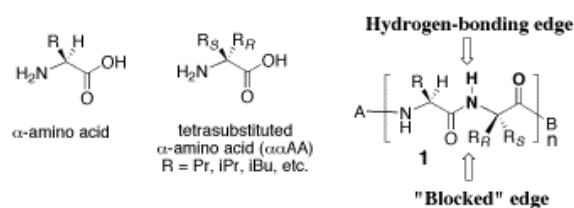
9

"Blocker" Monomer and Peptide Structures

α-amino acid

tetrasubstituted
α-amino acid (ααAA)
R = Pr, iPr, iBu, etc.

Hydrogen-bonding edge

1

"Blocked" edge

Figure 6

"Hydrophobic Core" of Aβ Assembly
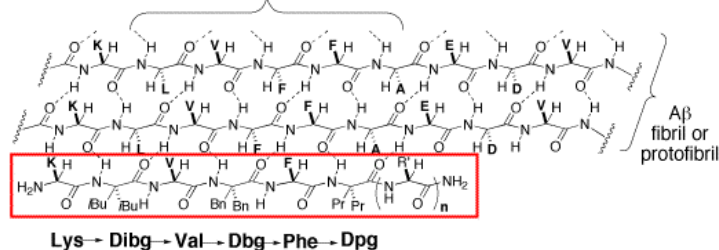
Aβ fibril or protofibril

Lys→ Dibg→ Val→ Dbg→ Phe→ Dpg

Figure 7

the synthesis of peptide **2** only by careful attention to the coupling protocols for incorporation of the ααAAs and particularly the methods for acylating the N-termini of the ααAAs.[30] Based on these successes, we are making a series of Aβ blockers with similar design.

In an interdisciplinary collaboration with the McCarley and Russo groups at LSU, we are testing the ability of blockers to inhibit the aggregation of Aβ$_{1-40}$. **Figure 8** shows the tapping mode AFM image of Aβ$_{1-40}$ solutions spotted on mica in the absence (*left*) or presence (*right*) of
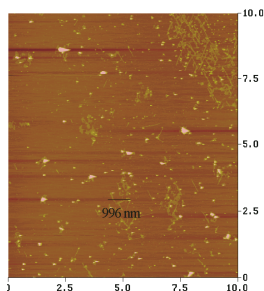
50 μM Aβ in 15 mM phosphate w/ 150 mM NaCl, pH = 7.3, 37 °C for 14 hrs, adsorbed on mica: Fibrils 500 - 750 nM in length
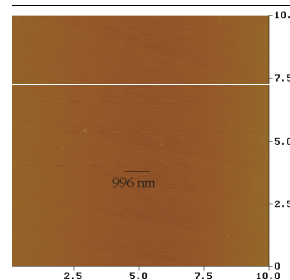
450 μM blocker peptide + 50 μM Aβ under same conditions: Spherical aggregates <100 nM diameter. If you don't see anything, that's the point.

Figure 8. Tapping Mode AFM of Aβ solutions deposited on mica.

an excess of peptide **2**. Very little aggregation of Aβ$_{1-40}$ is seen when the blocker molecule is present. To understand the mechanism by which the blockers work, surface tensiometry, light scattering and fluorescence photobleaching recovery are combined with AFM to determine the size, shape, stability and reversibility of the Aβ aggregates with and without various added blockers (and sometimes accelerants). The DLS data in **Figure 9** give some idea of the pace of late-stage aggregation while simultaneously that aggregates can be disrupted by sonication, only to "heal" quickly with addition of a peptide designed by Murphy.[29] Work with other peptides is underway. There is great uncertainty over the shape of the aggregates and how that changes with time or addition of inhibitor at various stages. The accelerated aggregation by addition of the Murphy peptide[29] produces less toxic, highly branched aggregates. So far, blocking efficiency does not correlate well with hydrophobic character as judged from surface tensiometry, suggesting that forces such as charge may be dominant.

Need. We have no capability to assess the charge on the aggregates, or its evolution. DLS experiments like **Figure 9** are only qualitative in the sense that just one angle is detected, but the larger problem is size polydispersity. It is axiomatic in light scattering that polydispersity confounds shape analysis.[31] Smaller aggregates might work their way through a GPC column for MALLS detection, but the sizes are too small to measure without QELS. Larger aggregates would not get into the column (protective prefilters) and would not be well resolved if they did.

10

Impact. The requested ZetaSizer will immediately permit us to investigate charge kinetics with and without inhibitor. In DLS mode, it will relieve the existing instrument from time-consuming measurements such as **Figure 9**. For the first time, the AFFF device can separate aggregates as a function of size. All sizes should be measurable, either by MALLS (the EOS) or DLS (the QELS attachment). Nearly uniform eluting particles should be much more susceptible to meaningful shape analysis and particle form factor modeling. By liberating one of the DAWN's, this request will facilitate the instrument development discussed in Sec. 4.8 for truly simultaneous, multiangle DLS and SLS on evolving samples. Initially, such an instrument would operate in batch mode to sense the polydisperse mixture; however, similar moments are detected (close to the *z*-average, [31;32]).

Figure 9. Lage-stage amyloid aggregation, disruption and acceleration by Murphy "blocker" (accelerant), measured at LSU.

Appropriateness of Equipment. During the NanoSizer demo, dendrimers of size and concentration appropriate to the early stages of Aβ aggregation were studied successfully. At the late stages of fibrillar aggregation, DLS would be inaccurate due to the single angle limitation, but trend studies like **Figure 9** would be just as meaningful if measured on the NanoSizer. While we have no preliminary AFFF data for Aβ, there is no better way to separate and then characterize these eventually huge aggregates. Thanks to the interdisciplinary nature of our team, there exists a chance to separate materials by AFFF, characterize by on-line DLS and SLS, and save the separated samples for AFM. This combines the best of light scattering (samples many particles without artifact) and AFM (unparalleled shape determination).

4.7 *Auxiliary Users Research (Table Legend Appears on Next Page)*

Investigator	Department	Academic Rank	Project	Content Code	Investigator Funded by
Vince Licata	Biological Sciences**	Assistant Professor	Protein conformation	1	NSF, NASA
David Norwood	Chemistry & Physics†	Associate Professor	Polysaccharide Solutions	2	La. Board of Regents
David Spivak	Chemistry	Assistant Professor	Supramolecular Network Materials	3	NSF CAREER
Britt Thomas	Chemistry	Assistant Professor	Cylindrical & Conical Vesicles	4	NSF CAREER
Karsten Thompson	Chemical Engineering	Associate Professor	Polyaphron Emulsions	5	NSF^

1. Protein conformational changes and size changes upon denaturation (LiCata). Large conformational shape changes in proteins are often accompanied by global size changes (R_h or R_g) of about 2 nm. Unfolding of proteins often doubles their size, involving R_h changes of 3-10 nm. Experimental techniques for the accurate measurement of and monitoring of such size changes include analytical ultracentrifugation, small angle X-ray scattering, and DLS. The ZetaSizer will allow our laboratory to monitor solvent and ligand induced conformational changes in several different protein systems, including Type 1 DNA polymerases and aspartate transcarbamylase. In addition, use of the ZetaSizer to measure the average size of the denatured state ensembles of proteins will allow us to address whether or not there is significant residual structure. The existence of, and functional role of protein denatured state residual structure is a relatively new area of investigation in the protein folding field, and the proposed measurements will contribute to understanding the role of the denatured state ensemble in the thermodynamics of protein folding. Direct comparisons between hydrodynamic properties measured by DLS to those calculated from simple modeled denatured state ensembles will be conducted.

2. Polyelectrolyte behavior of polysaccharides (Norwood). Two ongoing projects investigate the interaction of polysaccharide molecules with one another, with their counterions and with ions added to the solution. One project investigates the so-called "polyelectrolyte effect" in viscometry. It has long been known [33] that the viscosity of polyelectrolytes in low ionic strength solution presents a peak as a function of polymer concentration, but the explanation is still controversial. Attempts separate basically into explanations based on polymer-polymer interactions (the primary electroviscous effect) and polymer-counterion interactions (the secondary and tertiary electroviscous effects). Measurements of xanthan show such a peak and can eliminate the tertiary effect as a possible explanation if the polymer charge can be determined. The second project investigates the conformation changes and complexation of carrageenans for various ions of varying concentration. Current results, based on persistence lengths calculated from MALLS, suggest that iota-carrageenan aggregates rather than undergoing a coil-helix transition. The ability to size the polymer quickly under a series of polymer and salt concentrations would help reinforce (or refute) this controversial conclusion. The Malvern ZetaSizer was able to make preliminary measurements easily during the demo.

3. Supramolecular Network Materials (Spivak). Network materials will be developed based on non-covalent interactions The design principle is based on centroid units connected by non-covalent linkers. Synthesis of different linkers is underway with modular components that can be organized by various complexing species. A number of the network materials are anticipated to expand into large insoluble masses; others may discontinue growth at smaller aggregate sizes. The smaller aggregates will be measured, in particular with respect to time in order to obtain the kinetics of assembly. After trends are identified qualitatively by the single-angle DLS measurements on the requested ZetaSizer, more detailed studies can be accomplished on the existing DLS apparatus in the PI's laboratory. Kinetics will also be obtained at intervals for the large networks by size analysis at each interval, which can be accomplished by the requested AFFF/QELS instrument, which remains effective for large sizes. Indicators of shape will be available through R_h/R_g ratios. If the largest sizes exceed what can be measured by the QELS in a flowing system (transit time problems) the eluant can be collected for later batch DLS analysis.

4. Cylindrical & Conical Vesicles (Thomas). Phospholipid vesicles are among the simplest, yet most technologically relevant, self-assembling microstructures. The unusual *hollow*, *tubular* vesicles under study suggest nanofabrication, lithographic, purification and encapsulation applications, in addition to gene and drug delivery possibilities. Tailoring tubule dimensions, rigidity, mechanical

toughness and membrane reactivity for these potential applications are our focus. A typical lipid is *S*-1,2-bis(10,12 tricosadiynoyl)-sn-glycero-3-phosphocholine [twin fatty tails of -$(CH_2)_8$-C≡C-C≡C-$(CH_2)_9CH_3$]. Charge on the phospholipid bilayer membrane that forms the tubule plays a critical role in determining tubule dimensions. The interaction of forming tubules with dissolved encapsulants has generated a surprising discovery: when a small protein (lysozyme,12 kD) was encapsulated, the expected cylinder formation instead resulted in cones. Neither small-angle x-ray scattering nor spatially-resolved electron-beam energy-dispersive x-ray fluorescence spectroscopy have decisively located the protein along the conical vesicle. The zeta potential of the tubules, which will dominate the scattering in peptide mixtures, under varied pH and salt will provide insight concerning the extent and nature of the lipid-peptide interaction. A technical hurdle is the large length of the conical and cylindrical vesicles (~ 10 µm). The AFFF system may isolate smaller vesicles in the distribution for zeta potential by the efficient PALS technology, which does not require long-range motions. As an added benefit, more uniform cylinders and cones from the AFFF may facilitate device fabrication. Ultrasonic energy may be applied to produce smaller vesicles (of possibly different shape).

5. Polyaphron Emulsions (Thompson). Polyaphrons are a type of high-internal-phase-ratio emulsion, which are being used in a number of emerging applications including contaminant remediation.[34] Polyaphron solutions consist of micron-sized emulsion droplets, and they exhibit exceptional stability (over periods of years). Additionally, they can be destabilized using certain polyvalent cations, thus providing a simple switch-like mechanism to control stability in the various applications. For certain flow applications, it is important to understand how the droplet size distribution changes in response to parameters such as ionic strength, cation type, surface chemistry, and shear rate. The proposed apparatus will be used to characterize changes in size distribution of polyaphron droplets (due to breakup and/or coalescence) in shear flows of different conditions.

4.8 *Plans for Implementing the Research and Training Objectives.* The ZetaSizer requires little training. At-vendor training is included for some of the Wyatt components, and we will press Wyatt to include the others. Rather than pay $6500 for on-site training for the AFFF, we will negotiate with the vendor to give a minicourse on it. Through the Society of Plastics Engineers, LSU operates a semi-annual minicourse in polymer characterization for industrial scientists and technicians. In the first and second years of operation, HowTo guides and integrated training opportunities will be written into the course materials for Macromolecular Systems I and II (http://macro.LSU.edu/HowTo & http://macro.LSU.edu/CoreCourses/msweb4). These materials serve students and a diverse international readership, judging from inquiries.

  This is decidedly an instrument *acquisition* proposal, but students should have a chance to *build* instruments that advance the field. No commercial product provides *truly simultaneous, multiple angle* SLS and DLS. Such an instrument would contribute much. We recently used multiangle DLS to measure translational *and* rotational diffusion of rodlike probes in various polymer matrix solutions,[2;4] a tedious but powerful microrheology. Simultaneous multiple-angle DLS, while testing for solution stability with multiple angle SLS, would speed such research. Another class of problems awaiting such an instrument is responsive particles, like viruses or polypeptide coated silica (see **Figure 1**). Time-resolved single angle SLS and DLS measurements (submitted) suggested that stages of pH-induced virus aggregation can be observed, progressing over minutes from unimers and dimers to trimers (predominantly linear) and then on to more compact trimers and so forth. Multiple angle measurements of DLS and SLS simultaneously would provide the information to test this hypothesis. The seeds for a simultaneous instrument are in hand, in the form of an 8-input, wide-range Correlator.Com correlator mated to four (so far) separate photon counting modules through almost single-mode fiber optic cables. *When the GPC schedule allows*, the fiber optics are plugged into four viewports of an existing Wyatt DAWN, leaving fourteen others

for SLS. The requested EOS system would "retire" one of the DAWN's to hasten construction of this powerful new instrument. The DAWN is a good platform for it, thanks to convenient temperature control, easy laser swaps and good SLS software.

4.9 *Broader Impacts: Recruiting Students to Science.* *Newsweek* recently proclaimed LSU the nation's most diverse university. It was soon pointed out by the student newspaper (the *Reveille*, pronounced re-vile) that the data were faulty; nevertheless, LSU does boast a diverse student body, and this includes graduate Chemistry: 127 Ph.D. students + 7 M.S. students = 134 total (62 female, 72 male); 70 US Citizens: 32 African Americans; 2 Hispanic Americans; 1 Asian American; 60 international students from 20 different countries. Modern equipment is a universal attractor of students, but its effect on under-represented groups (the poor, regardless of ethnicity) is special: good equipment builds confidence. This is important in the impoverished south central US, because *many financially deprived students are not going very far from home for graduate school, no matter how hard anyone urges them to do so* (family commitments, first generation to attend college, no history of travel or relocation in the family, etc.). *After* the Ph.D., they often acquire the confidence and mobility of other socioeconomic groups, but this is even more reason for modern tools during their graduate years. A big challenge for LSU is attracting students from outside the south central US. Instrumentation helps here, too. REU interns could use the ZetaSizer and AFFF effectively, perhaps developing a curiosity about materials science in the process.

4.10 *Acquisition, Maintenance, Operation, Use Plans, and Shared Use*
Overall acquisition plan: The instruments will be purchased in the first year after we evaluate the similarly-priced Brookhaven ZetaPALS and FOQELS instruments to see if they outperform the Malvern ZetaSizer and check for any new developments.
Maintenance: The PI will be responsible for maintenance. Professor Russo has been a user and builder of light scattering instruments since 1978. About 60 reviewed publications involve scattering or GPC/MALLS and he reviews papers and proposals on these techniques. He may have help. Starting in January, 2004, LSU's Biodynamics Institute will enter an exciting new stage as an interdisciplinary bridge between Chemistry and Biological Sciences Departments, co-directed by the chairs of those departments. Biodynamics Institute scientist Dr. Rafael Cueto, whose background includes chromatography support as a Perkin Elmer representative, may continue in his current role of half-time maintenance/training for shared Macromolecular equipment. Graduate students will be involved in instrument maintenance because our IGERT award encourages students to assume teaching responsibilities and acquire hands-on skills.
Location: the equipment will reside in LSU Chemistry's Polymer Analysis Laboratory (PAL), the professional service and outreach arm of the LSU Macromolecular Studies Group. Barring changes due to a planned new Chemistry Annex, it will all go in Choppin 632, our share of which amounts to 400 sq.ft. with good power, internet connectivity, shared printers and adequate ventilation for volatile organic solvents, 24-hr access by keypad. PAL-specific items are stored behind a combination lock. Any changes related to the new Annex will offer these basics.
Severability: the equipment is severable from Choppin 632 and can be easily relocated.
Operation: We have taken pains *not* to incorporate the Polymer Analysis Lab as a cost center to encourage new users on the periphery of macromolecular science. Over 15 years, a growing body of equipment has served an increasing number of research groups. Industrial donations to the Macromolecular Development Fund and the Polymer Phenomenon Research Support Fund at the LSU Foundation help make this possible. Users must pay for their own supplies and consumables (solvents, pump parts, fittings, filters, etc.).
Time allocation: We will follow existing practice. New users are referred to appropriate "HowTo" web guides, then trained and qualified by the PI or Dr. Cueto. Users are categorized by capability

("Operator" or "Expert"). Qualified users request time on a whiteboard several weeks in advance. The main criterion is that the problem at hand might reasonably be solved without excessive risk to the instruments. Clusters of users with similar needs (e.g., they want to run the same solvent) may be rescheduled to minimize the number of changeovers. Schedules are adjusted when legitimate emergencies arise. About 35% of the time is reserved for maintenance, training, preliminary measurements for new users, including industry partners, workshops and the Macromolecular Systems I and II courses.

Budget for maintenance: Limited funds (currently about $2000/year) are made available to the Macromolecular Systems I and II classes, which will use this equipment. Other funds come from users; see *Operations*, above. Repairs can be made from indirect cost returned to the College and Department (15% of 47% indirect costs based on modified total direct costs).

Other support services for maintenance: The College of Basic Sciences maintains excellent glass and machine shops, two full-time persons each, which prove useful for minor repairs, modifications and extensions of instruments. Either may be used for $6.00 per hour. Chemistry and Physics recently merged their electronics shops; a single three-person shop operated by Physics provides, if anything, better service at $10/hour. The total annual budget (salaries & operating cost) of these shops for operation, maintenance and administration is $345,899.

Results from Prior NSF Support. The table below shows support from one relevant NSF grant for the PI and co-PI's, though some enjoy additional NSF support.

Investigator	NSF Award	Publications 1999-2004	Content code	Notes
Paul Russo, PI	DMR-0075810	14	1.	
Robin McCarley, co-PI	CHE-0108961	23	2.	
Robert Hammer, co-PI	CHE-9732195	20	3.	REU

1. *Complex Fluids with Extended, Rigid Components.* (Russo, PI). The work has four components: 1) polymer physics in complex fluids, especially diffusion and rotation of rodlike polymers in solutions containing other rods, random coils or globules; 2) development of core-shell particles with SiO_2 interior and homo- or co-polypeptide exterior; 3) study of self-assembling bolaform amphiphiles and hexaruthenium complexes in collaboration with others; and, 4) other collaborations. See Biographical Sketch for the most pertinent publications.

2. *Stabilized Molecular Assemblies*. (McCarley, PI) The theme of the project is investigation of the properties of novel stimuli-responsive macromolecule host systems fabricated in our laboratories. The project entails 1) synthesis of oligo(pyrrole)- and oligo(*N*-isopropylacrylamide)-terminated poly(propylene imine) dendrimers and subsequent characterization with respect to their abilities to act as triggered-release containers for small molecules, 2) mass spectral and NMR studies of the oligomeric terminal groups through the use of appropriate model oligomers (oligo(3-alkylpyrroles) and oligo(*N*-isopropylacrylamide), 3) collaborative molecular modeling and neutron scattering of the oligo(pyrrole)-terminated poly(propylene imine) dendrimers; and, 4) host-guest investigations of other containers (carbon nanotubes, cored nanoparticles) appended with the responsive oligomers.

3. *Chemical and Biochemical Research Experience for Advanced Undergraduates.* (Hammer, PI; McCarley, co-PI) A very successful REU site was established, which continues under a renewal award (0139656, S. Watkins, PI). The current grant is operated jointly with the Chemical Engineering and Biological Sciences Departments, attesting to the rise of interdisciplinary activities. About 50% of the 68 students trained over the past 7 years have gone on to graduate school; about 75% of the students are from underrepresented groups.

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BIOGRAPHICAL SKETCH

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Specializations: Polymer Chemistry, Optical Measurements, Gels, Liquid Crystals, Rodlike Polymers, Polymer-Colloid Composites, Fibril-forming molecules

Professional : **Preparation**	B.S. in Chemistry, University of Wisconsin--River Falls, 1976
	Ph.D. in Chemistry, University of Minnesota, 1981 Postdoctoral Associate, University of Massachusetts, 1981-1983

Appointments:		
	2002-present	Roy Paul Daniels Professor of Chemistry
	1995-2002	Professor of Chemistry--LSU
	1988-1995	Associate Professor of Chemistry--LSU
	1983-1988	Assistant Professor of Chemistry--LSU

Temporary Positions: Visiting Scientist, Wright Research and Development Center, Materials Laboratory--Polymers Branch. Wright Patterson Air Force Base, Dayton, Ohio, August, 1989.

Faculty Sabbatical, Sandia National Laboratory, Department of Organic & Electronic Materials, Albuquerque, New Mexico, January-June, 1991.

Five Publications Relevant to the Proposed Activities

- Study of Rodlike Homopolypeptides by Gel Permeation Chromatography with Light Scattering Detection: Validity of Universal Calibration and Stiffness Assessment, E. Temyanko, P. S. Russo and H. Ricks, *Macromolecules*, 34, 582-586 (2001).
- Teaching Light Scattering to Exemplify and Reinforce Basic Principles, D. S. Poche', P. S. Russo, B. Fong, E. Temyanko and H. Ricks, *J. Chem. Ed.*, 76 (November), 1534-1538 (1999).
- Rotational and Translational Diffusion of a Rodlike Virus in Random Coil Polymer Solutions, R. Cush, P.S. Russo, Z. Kucukyavuz, Z. Bu, D. Neau, D. Shih, S. Kucukyavuz, H. Ricks, *Macromolecules*, 30, 4920-4926 (1997).
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- Dynamic Light Scattering from Rigid and Nearly Rigid Rods, P. S. Russo, in "Dynamic Light Scattering, the Method and Some Applications", W. Brown, ed., Oxford University Press: Oxford, 1993. (review)

Other Publications

- Colloidal Crystals of Silica-Homopolypeptide Composite Particles, Brian Fong, Sibel Turksen, Paul S. Russo, and Wieslaw Stryjewski, *Langmuir*, accepted for first issue of 2004. Published on web: http://dx.doi.org/10.1021/la034762u
- NMR Investigations of the Structure of Water-soluble Poly(ethylene oxide) Complexes with Polystyrene Sulfonate Copolymers, R. Cong, R. Pelton, P.S. Russo, A. D. Bain, I. Negulescu and Z. Zhou, *Colloid and Polymer Science*, 281(2); 150-156 (2003).
- Factors Affecting the Size of Aqueous Poly(vinylphenol-co-potassium styrenesulfonate)/Poly(ethylene oxide) Complexes. R. Cong; R. Pelton; P. Russo; G. Doucet, *Macromolecules* , 36(1), 204-209(2003).
- Self-Diffusion of a Rodlike Virus in the Isotropic Phase, R. C.; Cush and P. S. Russo, *Macromolecules*; 35(23); 8659-8662 (2002).
- Organophilic Colloidal Particles with a Synthetic Polypeptide Coating, B. Fong and P.S. Russo, *Langmuir*, *15*(13); 4421-4426 (1999).

Synergistic Activities (Last 5 Years)

- Director of NSF-IGERT program, "Teaching Craft for Macromolecular Creativity".
- Outreach websites for classroom (http://russo.chem.lsu.edu/CourseInfo.html) and laboratory (http://russo.chem.lsu.edu/howto/HowTo.html). Also website for the LSU Macromolecular Studies Group (http://msg.chem.lsu.edu/).
- Member, Chancellor's Taskforce on Administrative Policy (improving efficiency of academic research operations).
- Co-advisor (with R. Strongin) of Student Affiliates of the American Chemical Society
- Two new courses, *Macromolecular Studies I* and *II*, that emphasize hands-first (not just hands-on) training in a team-taught industry/lab/lecture environment.
- Outreach to HanYang University in Seoul, Korea (2 visitors, a third planned)
- Outreach to other Louisiana universities to create the Applied Polymer Technology Extension Consortium, a teaching/research/service organization approved by the legislature and signed into law by the Governor in the summer of 2003.

Collaborators in Last 5 Years

At LSU: T. Bricker, W. H. Daly, M. Radosz, R. Hammer, R. McCarley, M. McLaughlin; D. Spivak

Elsewhere: P. Dubin (Indiana U. Purdue U. at Indianapolis); G. Newkome (U. Akron); P. Butko (U. Southern Mississippi); R. Epand (McMaster); D. De Kee (Tulane); M. Srinivasarao (Georgia Tech); Robert Pelton (McMaster)

Graduate and Postdoctoral Advisors

Frank E. Karasz (postdoctoral) -- University of Massachusetts (Polymer Science)

Kenneth H. Langley (postdoctoral) -- University of Massachusetts (Physics), retired

Wilmer G. Miller (thesis) -- University of Minnesota (Chemistry), retired

Graduate Students & Postdocs, Last 5 Years (Total all years: 8 Ph.D., 3 Masters, 4 postdocs)

Ph.D.: Lucille Smith-Wright (U.S. Geological Service, Baton Rouge), Randy Cush (Syngenta)

Master's: Brian Fong (Buckeye Technologies, Memphis, TN); Elena Temyanko (Univ. of Arizona, Tuscon, AZ).

Postdoc: Rongjuan Cong (seeking job near husband)

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Professional Preparation

University of Illinois, Urbana, IL	Chemistry	B.S., 1985
University of Minnesota, Minneapolis, MN	Organic Chemistry	Ph.D., 1990

Appointments

2002 -present   Professor, Department of Chemistry, Louisiana State University, Baton Rouge, LA

1998-2002   Associate Professor, Department of Chemistry, Louisiana State University, Baton Rouge, LA

1992-1998   Assistant Professor, Department of Chemistry, Louisiana State University, Baton Rouge, LA

1990-1992   Postdoctoral Fellow, Swiss Federal Institute of Technology (ETH), Zurich, Switzerland, with Professor Dr. Albert Eschenmoser

1983-1984   Cooperative Education Chemist, Nalco Chemical Company, Naperville, Illinois

Publications

1. Yanwen Fu, Marcus A. Etienne, and Robert P. Hammer. Facile Synthesis of α,α-Diisobutylglycine and Anchoring Its Derivatives onto PAL-PEG-PS Resin. *J. Org. Chem.* **68**, 9854-9857 (2003).

2. Yanwen Fu and Robert P. Hammer. Efficient Acylation of the *N*-Terminus of Highly Hindered $C^{\alpha,\alpha}$-Disubstituted α-Amino Acids via Amino Acid Symmetrical Anhydrides. *Org. Lett.* **4**, 237-240 (2002).

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Five Other Significant Publications

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2. Yun Wang, Bikas Vaidya, Hannah D. Farquar, Wieslaw Stryjewski, Robert P. Hammer, Robin L. McCarley, Steven A. Soper, Yu-Wei Cheng and Francis Barany. Microarrays

assembled in microfluidic chips fabricated from poly(methyl methacrylate) for the detection of low-abundant DNA mutations. *Anal. Chem.* **75**, 1130-1140 (2003).

3. Serhii Pakhomov, Robert P. Hammer, Bijaya K. Mishra, and Britt N. Thomas. Chiral tubule self-assembly from an achiral diynoic lipid. *Proc. Natl. Acad. Sci. USA* **100**, 3040-3042 (2003).

4. Musundi Wabayele, Musundi B. Wabuyele, Hannah Farquar, Wieslaw Stryjewski, Robert P. Hammer, Steven A. Soper Yu-Wei Cheng, and Francis Barany. Approaching real-time molecular diagnostics: Single-pair fluorescence resonance energy transfer (spFRET) detection for the analysis of low abundant point mutations in K-ras oncogenes. *J. Am. Chem. Soc.* **125**, 6937-6945 (2003).

5. Robert P. Hammer, Clyde V. Owens, Seok-Hwan Hwang, Christie M. Sayes, and Steven A. Soper. Asymmetrical, Water-Soluble Phthalocyanine Dyes for Covalent Labeling of Oligonucleotides. *Bioconjugate Chem.* **13**, 1244-1252 (2002).

Synergistic Activities

- LSU Distinguished Faculty Award, 2003
- Special Member, Shared Research Instrumentation Study Section, National Institutes of Health, Bethesda, MD, October 27-28, 2003.
- Director (PI), Louisiana State University Research Experience for Undergraduates (REU) Chemistry and Biochemistry Summer Program, 1995-2001.
- Consultant on new methods for fragment synthesis of oligonucleotides, Dupont-Merck Pharmaceutical Company, 1993.
- Director, Louisiana State University Peptide and Protein Facility, 2002-present
- Presiding Officer for Division of Organic Chemistry session: "Host-guest & Self-assembly Interactions," American Chemical Society, 211th National Meeting, New Orleans, Louisiana, March 24-28, 1996.
- Referee of research proposals, submitted to National Science Foundation, Petroleum Research Fund, Research Corporation.
- Referee of research articles, submitted to *Biochemistry, Biopolymers, J. Peptide Research, Chem. Commun., J. Am. Chem. Soc., J. Org. Chem.*, *Tetrahedron, Tetrahedron Lett., Org. Lett*.

Collaborations and Other Affiliations

Collaborators and Co-editors

At LSU: M. L. McLaughlin, M. Vicente, S. A. Soper, P. Russo, R. L. McCarley.

Elsewhere: F. Barany (Cornell U. Med. College), D. R. Riese (Purdue U),

T. A. Keiderling (Univ. Illinois-Chicago), G. B. Fields (Florida Atlantic University).

Graduate and Post-doctoral Advisors

Ph.D. Mentor: George Barany (U. Minnesota)

Postdoctoral Advisor: Albert Eschenmoser (ETH-Zurich)

Postdoctoral Fellows and Graduate Students Advised

Postdoctoral Researchers: Cornelis Vlaar, Kris Moffett, Maria Benites, Tod Miller, Serhii Pakhomov, Guifa Su

Graduate Students: Maria Fernandez, Melissa Cameron, Andrea Saurage, Hong Fan, Nanfei Zou, Sheila Rushing, Chris Wysong, Yanwen Fu, Hannah Farquar, John Whitehead, Marcus Etienne, Jia Wang

Robin L. McCarley

Department of Chemistry
Louisiana State University
Baton Rouge, LA 70803
(225) 578-3239
tunnel@ lsu.edu
Group Web Site: http://www.chem.lsu.edu/htdocs/people/rlmccarley/mccarley/rlm.html

Specializations:

Electrochemical synthesis of highly oriented conducting polymers in organized media, particularly dendrimers and monolayers; Development of chemically modified surfaces for use in microanalytical devices and electrochemical and mass sensors; Scanning probe microscopy investigations of surfaces capable of inducing protein deposition, especially Alzheimer's protein; Template-directed synthesis of metal nanoparticles and their characteristics.

**Professional
Preparation:**

B.A. in Chemistry, Lake Forest College, Lake Forest, Illinois, May 1986

Ph.D. in Chemistry, The University of North Carolina, Chapel Hill, NC, July 1990

NSF Postdoctoral Fellow in Chemistry, The University of Texas, Austin, TX, 1990-1992

Appointments:

August 2002–present	Professor of Chemistry–LSU
August 1998–August 2002	Associate Professor of Chemistry–LSU
July 1992-August 1998	Assistant Professor of Chemistry–LSU

Five Publications Relevant to the Proposed Activities

- E.E. Doomes, P.N. Floriano, R.W. Tittsworth, R.L. McCarley, and E.D. Poliakoff, *Anomalous XANES Spectra of Octadecanethiol Adsorbed on Ag(111)*, *J. Phys. Chem. B* **2003**, *107*, 10193-10197.

- P.N. Floriano, C.O. Noble, IV, J.M. Schoonmaker, E.D. Poliakoff, and R.L. McCarley, *Cu(0) Nanoclusters Derived from Poly(propylene imine) Dendrimer Complexes of Cu(II)*, *J. Am. Chem. Soc.* **2001**, *123*, 10545-10553.

- T.D. McCarley, C.J. Dubois, Jr., C.O. Noble, IV, and R.L. McCarley, *MALDI-MS of Poly(3-hexylthiophene) Synthesized by Chemical Oxidative with FeCl₃*, *Macromolecules* **2001**, *34*, 7999-8004.

- C.O. Noble, IV and R.L. McCarley, *Pyrrole-Terminated Diaminobutane (DAB) Dendrimer Monolayers on Gold—Oligomerization of Peripheral Groups and Adhesion Promotion of Poly(pyrrole) Films*, *J. Am. Chem. Soc.*, **2000**, *127*, 6518-6519.

- C.O. Noble, IV and R.L. McCarley, *Surface-Confined Monomers on Electrode Surfaces. 7. Synthesis of Pyrrole-Terminated Poly(propylene imine) Dendrimers*, *Organic Letters* **1999**, *1*, 1021-1023.

Five Other Significant Publications

- E.E. Doomes, R.W. Zurales, R.L. McCarley, and E.D. Poliakoff, *Correlations Between Heterocycle Ring Size and X-ray Spectra*, *J. Chem. Phys.* **2003**, *119*, 4399-4404.

- Y. C. Xu, B. Vaidya, A. B. Patel, S. M. Ford, R. L. McCarley, and S. A. Soper *Solid-phase reversible immobilization in microfluidic chips for the purification of dye-labeled DNA sequencing fragments*, *Anal. Chem.* **2003**, *75*, 2975-2984.

- S.L. Caston and R.L. McCarley, *Characteristics of Nanoscopic Band Electrodes*, *J. Electroanal. Chem.* **2002**, *529*, 124-134.

- S.A. Soper, A.C. Henry, B. Vaidya, M. Galloway, M. Wabuyele, and R.L. McCarley, *Surface Modification of Polymer-Based Microfluidic Devices, Anal. Chim. Acta*. **2002**, *470*, 87-99.

- B. Vaidya, S.A. Soper, and R.L. McCarley, *Surface Modification and Characterization of Microfabricated Poly(carbonate) Devices: Manipulation of Electroosmotic Flow, The Analyst* **2002**, *127*, 1289-1292.

Synergistic Activities (up to 5)
- Director, Service-learning Program for East Baton Rouge Parish Kindergarten Classes, McCarley Research Group
- LSU Distinguished Faculty Award, 2003
- Director of Dreyfus Foundation Instructional Digital Video Program, 2001-present, http://www.chem.lsu.edu/htdocs/people/rlmccarley/mccarley/dreyfus1.html
- LSU College of Basic Sciences Faculty Teaching Award, 2002
- Co-Director (Co-PI), Louisiana State University Research Experience for Undergraduates (REU) Chemistry and Biochemistry Summer Program, 1995-2001

Collaborations and Other Affiliations
(a) Collaborators and Co-Editors
Larry Curtin, Youngstown State University
Patrick Limbach, University of Cincinnati
Erwin Poliakoff, LSU
Robert Strongin, LSU
(b) Graduate and Post-doctoral Advisors
Royce Murray, UNC-Chapel Hill
Allen Bard, UT-Austin
(c) Postdoctoral Fellows and Graduate Students Advised within the Past 5 Years
3 Postdoctoral Fellows
    Bikas Vaidya, Lynntech; Grigor Bantchev, LSU; Sreelatha Subramanian, LSU
17 Graduate Students (10 Current)
        Song Lin, VarTech; Cory Schomburg, ATMI Incorporated; Pierre Floriano, Univ. Texas; Sonya Caston, USDA; Alyssa Henry, National Institute of Standards and Technology; Charles O. Noble, Liposome Research Center Laboratory at California Pacific Medical Center; Jed Aucoin, Lockheed-Martin; Amy Morara, LSU; Alison Smith, LSU; Mariah McMasters, LSU; Suying Wei, LSU; Henry P. Wiggins, LSU; Jowel Bolivar, LSU; Rebecca M. Brauch, LSU; Chet M. Champagne, LSU; Ravindra Desilva, LSU; Yuming Yang, LSU.

ORGANIZATION				**FOR NSF USE ONLY**		
Louisiana State University & Agricultural and Mechanical College				PROPOSAL NO.	DURATION (months)	
					Proposed	Granted
PRINCIPAL INVESTIGATOR / PROJECT DIRECTOR				AWARD NO.		
Paul S Russo						

A. SENIOR PERSONNEL: PI/PD, Co-PI's, Faculty and Other Senior Associates (List each separately with title, A.7. show number in brackets)	NSF Funded Person-months			Funds Requested By proposer	Funds granted by NSF (if different)
	CAL	ACAD	SUMR		
1. **Paul S Russo - none**	**0.00**	**0.00**	**0.00**	$ **0**	$
2. **Robert P Hammer - none**	**0.00**	**0.00**	**0.00**	**0**	
3. **Robin L McCarley - none**	**0.00**	**0.00**	**0.00**	**0**	
4.					
5.					
6. (**0**) OTHERS (LIST INDIVIDUALLY ON BUDGET JUSTIFICATION PAGE)	**0.00**	**0.00**	**0.00**	**0**	
7. (**3**) TOTAL SENIOR PERSONNEL (1 - 6)	**0.00**	**0.00**	**0.00**	**0**	
B. OTHER PERSONNEL (SHOW NUMBERS IN BRACKETS)					
1. (**0**) POST DOCTORAL ASSOCIATES	**0.00**	**0.00**	**0.00**	**0**	
2. (**0**) OTHER PROFESSIONALS (TECHNICIAN, PROGRAMMER, ETC.)	**0.00**	**0.00**	**0.00**	**0**	
3. (**0**) GRADUATE STUDENTS				**0**	
4. (**0**) UNDERGRADUATE STUDENTS				**0**	
5. (**0**) SECRETARIAL - CLERICAL (IF CHARGED DIRECTLY)				**0**	
6. (**0**) OTHER				**0**	
TOTAL SALARIES AND WAGES (A + B)				**0**	
C. FRINGE BENEFITS (IF CHARGED AS DIRECT COSTS)				**0**	
TOTAL SALARIES, WAGES AND FRINGE BENEFITS (A + B + C)				**0**	
D. EQUIPMENT (LIST ITEM AND DOLLAR AMOUNT FOR EACH ITEM EXCEEDING $5,000.)					
Autoinjector/degasser/pump			$ **13,500**		
Computers			**3,000**		
EOS/AFFF($164122) less CostShare ($73357)			**90,765**		
ZetaSizer			**63,900**		
TOTAL EQUIPMENT				**171,165**	
E. TRAVEL 1. DOMESTIC (INCL. CANADA, MEXICO AND U.S. POSSESSIONS)				**0**	
2. FOREIGN				**0**	
F. PARTICIPANT SUPPORT COSTS					
1. STIPENDS $ **0**					
2. TRAVEL **0**					
3. SUBSISTENCE **0**					
4. OTHER **0**					
TOTAL NUMBER OF PARTICIPANTS (**0**) TOTAL PARTICIPANT COSTS				**0**	
G. OTHER DIRECT COSTS					
1. MATERIALS AND SUPPLIES				**0**	
2. PUBLICATION COSTS/DOCUMENTATION/DISSEMINATION				**0**	
3. CONSULTANT SERVICES				**0**	
4. COMPUTER SERVICES				**0**	
5. SUBAWARDS				**0**	
6. OTHER				**0**	
TOTAL OTHER DIRECT COSTS				**0**	
H. TOTAL DIRECT COSTS (A THROUGH G)				**171,165**	
I. INDIRECT COSTS (F&A)(SPECIFY RATE AND BASE)					
(Rate: , Base:)					
TOTAL INDIRECT COSTS (F&A)				**0**	
J. TOTAL DIRECT AND INDIRECT COSTS (H + I)				**171,165**	
K. RESIDUAL FUNDS (IF FOR FURTHER SUPPORT OF CURRENT PROJECTS SEE GPG II.C.6.j.)				**0**	
L. AMOUNT OF THIS REQUEST (J) OR (J MINUS K)				$ **171,165**	$
M. COST SHARING PROPOSED LEVEL $ **73,357**		AGREED LEVEL IF DIFFERENT $			

PI/PD NAME	FOR NSF USE ONLY		
Paul S Russo	INDIRECT COST RATE VERIFICATION		
ORG. REP. NAME*	Date Checked	Date Of Rate Sheet	Initials - ORG

1 *ELECTRONIC SIGNATURES REQUIRED FOR REVISED BUDGET

SUMMARY
PROPOSAL BUDGET

Cumulative

ORGANIZATION	FOR NSF USE ONLY		
Louisiana State University & Agricultural and Mechanical College	PROPOSAL NO.	DURATION (months)	
		Proposed	Granted
PRINCIPAL INVESTIGATOR / PROJECT DIRECTOR	AWARD NO.		
Paul S Russo			

A. SENIOR PERSONNEL: PI/PD, Co-PI's, Faculty and Other Senior Associates (List each separately with title, A.7. show number in brackets)	NSF Funded Person-months			Funds Requested By proposer	Funds granted by NSF (if different)
	CAL	ACAD	SUMR		
1. **Paul S Russo - none**	0.00	0.00	0.00	$ 0	$
2. **Robert P Hammer - none**	0.00	0.00	0.00	0	
3. **Robin L McCarley - none**	0.00	0.00	0.00	0	
4.					
5.					
6. ( ) OTHERS (LIST INDIVIDUALLY ON BUDGET JUSTIFICATION PAGE)	0.00	0.00	0.00	0	
7. (**3**) TOTAL SENIOR PERSONNEL (1 - 6)	0.00	0.00	0.00	0	
B. OTHER PERSONNEL (SHOW NUMBERS IN BRACKETS)					
1. (**0**) POST DOCTORAL ASSOCIATES	0.00	0.00	0.00	0	
2. (**0**) OTHER PROFESSIONALS (TECHNICIAN, PROGRAMMER, ETC.)	0.00	0.00	0.00	0	
3. (**0**) GRADUATE STUDENTS				0	
4. (**0**) UNDERGRADUATE STUDENTS				0	
5. (**0**) SECRETARIAL - CLERICAL (IF CHARGED DIRECTLY)				0	
6. (**0**) OTHER				0	
TOTAL SALARIES AND WAGES (A + B)				0	
C. FRINGE BENEFITS (IF CHARGED AS DIRECT COSTS)				0	
TOTAL SALARIES, WAGES AND FRINGE BENEFITS (A + B + C)				0	
D. EQUIPMENT (LIST ITEM AND DOLLAR AMOUNT FOR EACH ITEM EXCEEDING $5,000.) $ 171,165					
TOTAL EQUIPMENT				171,165	
E. TRAVEL 1. DOMESTIC (INCL. CANADA, MEXICO AND U.S. POSSESSIONS)				0	
2. FOREIGN				0	
F. PARTICIPANT SUPPORT COSTS					
1. STIPENDS $ 0					
2. TRAVEL 0					
3. SUBSISTENCE 0					
4. OTHER 0					
TOTAL NUMBER OF PARTICIPANTS (**0**) TOTAL PARTICIPANT COSTS				0	
G. OTHER DIRECT COSTS					
1. MATERIALS AND SUPPLIES				0	
2. PUBLICATION COSTS/DOCUMENTATION/DISSEMINATION				0	
3. CONSULTANT SERVICES				0	
4. COMPUTER SERVICES				0	
5. SUBAWARDS				0	
6. OTHER				0	
TOTAL OTHER DIRECT COSTS				0	
H. TOTAL DIRECT COSTS (A THROUGH G)				171,165	
I. INDIRECT COSTS (F&A)(SPECIFY RATE AND BASE)					
TOTAL INDIRECT COSTS (F&A)				0	
J. TOTAL DIRECT AND INDIRECT COSTS (H + I)				171,165	
K. RESIDUAL FUNDS (IF FOR FURTHER SUPPORT OF CURRENT PROJECTS SEE GPG II.C.6.j.)				0	
L. AMOUNT OF THIS REQUEST (J) OR (J MINUS K)				$ 171,165	$
M. COST SHARING PROPOSED LEVEL $ **73,357** AGREED LEVEL IF DIFFERENT $					

PI/PD NAME	FOR NSF USE ONLY		
Paul S Russo	INDIRECT COST RATE VERIFICATION		
ORG. REP. NAME*	Date Checked	Date Of Rate Sheet	Initials - ORG

C ***ELECTRONIC SIGNATURES REQUIRED FOR REVISED BUDGET**

Budget Justification

Prices are based on recent quotations (see attached supplemental documents) and reflect academic discounts.

The main items are described in detail in the proposal. Following is justification for some of the smaller items and accessories.

Wyatt Quote
"High Temp" accessory: required to have *any* temperature control, even though true high-temperature measurements are not contemplated.

OptiLab DSP and DNDC kit: high-sensitivity differential refractive index detector, required because many of the particles to be studied have enormous molecular weights, requiring low concentrations to avoid swamping out the light scattering detectors (or entering a multiple-scattering regime). We have been unable to measure dn/dc for some recent colloidal-size virus particles with existing differential refractometers that were the best available 15 years ago.

Comet: a device to help clean the cells; experience shows they do become dirty and require careful, time-consuming cleaning.

On-site training for AFFF (delete): We will take training on the AFFF during the complimentary training session for the EOS system.

Malvern Quote
45 µL cuvette kit: for small volumes (e.g., amyloid beta)

dip cell kit: required for nonaqueous measurements.

PC's: one for the Wyatt system, one for the ZetaSizer, and one for the existing Wyatt DSP that will remain in this facility (that system now uses a computer that is, no kidding, twelve years old; even with updates, it is far from satisfactory, making it difficult to share data and analysis programs).

University Cost Sharing

LSU promises the amount on Line M in direct support of the equipment acquisition. These funds come from the Vice Chancellor of Research and Graduate Studies.

Current and Pending Support
(See GPG Section II.D.8 for guidance on information to include on this form.)

The following information should be provided for each investigator and other senior personnel. Failure to provide this information may delay consideration of this proposal.

Investigator: **Paul Russo**	Other agencies (including NSF) to which this proposal has been/will be submitted.

Support: ☒ Current   ☐ Pending   ☐ Submission Planned in Near Future   ☐ *Transfer of Support

Project/Proposal Title: **Inhibition of Fibrillogenesis with Beta-Strand Mimics**

Source of Support: **NIH-NIA (with Robert Hammer as PI)**
Total Award Amount: $ **1,200,000** Total Award Period Covered: **05/30/00 - 04/30/05**
Location of Project: **LSU**
Person-Months Per Year Committed to the Project.   Cal:**0.00**   Acad: **1.00**   Sumr: **1.00**

Support: ☒ Current   ☐ Pending   ☐ Submission Planned in Near Future   ☐ *Transfer of Support

Project/Proposal Title: **Teaching Craft for Macromolecular Creativity**

Source of Support: **NSF-DGE**
Total Award Amount: $ **3,200,000** Total Award Period Covered: **07/01/00 - 06/30/05**
Location of Project: **LSU**
Person-Months Per Year Committed to the Project.   Cal:**0.00**   Acad: **2.00**   Sumr: **0.00**

Support: ☒ Current   ☐ Pending   ☐ Submission Planned in Near Future   ☐ *Transfer of Support

Project/Proposal Title: **Complex Fluids with Extended, Rigid Components**

Source of Support: **NSF-DMR**
Total Award Amount: $ **562,000** Total Award Period Covered: **06/01/00 - 05/30/05**
Location of Project: **LSU**
Person-Months Per Year Committed to the Project.   Cal:**0.00**   Acad: **1.00**   Sumr: **1.00**

Support: ☒ Current   ☐ Pending   ☐ Submission Planned in Near Future   ☐ *Transfer of Support

Project/Proposal Title: **Mechanism of Action of the Cytolytic Toxin Cyt1A from Bacillus Thuringiensis**

Source of Support: **USDA-NRICGP (subcontract from U. Southern Mississippi)**
Total Award Amount: $ **19,000** Total Award Period Covered: **03/01/01 - 10/01/04**
Location of Project: **LSU**
Person-Months Per Year Committed to the Project.   Cal:**0.00**   Acad: **0.00**   Sumr: **0.00**

Support: ☐ Current   ☒ Pending   ☐ Submission Planned in Near Future   ☐ *Transfer of Support

Project/Proposal Title: **Acquisition of a Light Scattering System for Research and Education at the Polymer/Colloid Interface (This Proposal)**

Source of Support: **NSF-DMR**
Total Award Amount: $ **171,165** Total Award Period Covered: **06/01/04 - 05/31/05**
Location of Project: **LSU**
Person-Months Per Year Committed to the Project.   Cal:**0.00**   Acad: **0.00**   Summ: **0.00**

---

*If this project has previously been funded by another agency, please list and furnish information for immediately preceding funding period.

Current and Pending Support
(See GPG Section II.D.8 for guidance on information to include on this form.)

The following information should be provided for each investigator and other senior personnel. Failure to provide this information may delay consideration of this proposal.

Investigator: **Robert Hammer**	Other agencies (including NSF) to which this proposal has been/will be submitted.

Support: ☒ Current ☐ Pending ☐ Submission Planned in Near Future ☐ *Transfer of Support

Project/Proposal Title: **Inhibition of Fibrillogenesis with Beta-Strand Mimics (PI: Hammer)**

Source of Support: **NIH NIA (R01 AG17983)**
Total Award Amount: $ **1,189,720** Total Award Period Covered: **04/01/00 - 03/31/04**
Location of Project: **Louisiana State University, Baton Rouge, LA**
Person-Months Per Year Committed to the Project. Cal:**0.00** Acad: **0.90** Sumr: **1.00**

Support: ☒ Current ☐ Pending ☐ Submission Planned in Near Future ☐ *Transfer of Support

Project/Proposal Title: **Micro-Instrument Platforms for Genetic-Based Analysis (PI: Soper)**

Source of Support: **NIH NCI (R24 CA842625)**
Total Award Amount: $ **2,883,730** Total Award Period Covered: **04/01/00 - 03/31/05**
Location of Project: **Louisiana State University, Baton Rouge, LA**
Person-Months Per Year Committed to the Project. Cal:**0.00** Acad: **0.90** Sumr: **0.00**

Support: ☒ Current ☐ Pending ☐ Submission Planned in Near Future ☐ *Transfer of Support

Project/Proposal Title: **High Throughput DNA Sequencing Using Nano-Reactors and Micro-Electrophoresis (PI: Soper)**

Source of Support: **NIH HGI (R01 HG01449)**
Total Award Amount: $ **1,446,008** Total Award Period Covered: **04/01/00 - 03/31/04**
Location of Project: **Louisiana State University, Baton Rouge, LA**
Person-Months Per Year Committed to the Project. Cal:**0.00** Acad: **0.90** Sumr: **1.00**

Support: ☒ Current ☐ Pending ☐ Submission Planned in Near Future ☐ *Transfer of Support

Project/Proposal Title: **Mechanism and Inhibition of Collagenolytic Activity (PI: Fields, Florida Atlantic Univ.)**

Source of Support: **NIH NCI (R01 CA098799)**
Total Award Amount: $ **750,000** Total Award Period Covered: **12/01/02 - 11/30/07**
Location of Project: **Louisiana State University, Baton Rouge**
Person-Months Per Year Committed to the Project. Cal:**0.00** Acad: **0.45** Sumr: **1.00**

Support: ☒ Current ☐ Pending ☐ Submission Planned in Near Future ☐ *Transfer of Support

Project/Proposal Title: **Synthesis and Characterization of Fluorescent Porphyrinoid Bioconjugates for Imaging and Bioanalyses (PI: Vicente)**

Source of Support: **NSF CRC (CHE-0304833)**
Total Award Amount: $ **750,000** Total Award Period Covered: **07/01/03 - 06/30/06**
Location of Project: **Louisiana State University, Baton Rouge, LA**
Person-Months Per Year Committed to the Project. Cal:**0.00** Acad: **0.45** Summ: **1.00**

*If this project has previously been funded by another agency, please list and furnish information for immediately preceding funding period.

USE ADDITIONAL SHEETS AS NECESSARY

Current and Pending Support
(See GPG Section II.D.8 for guidance on information to include on this form.)

The following information should be provided for each investigator and other senior personnel. Failure to provide this information may delay consideration of this proposal.

Investigator: **Robert Hammer**	Other agencies (including NSF) to which this proposal has been/will be submitted.

Support: ☐ Current ☒ Pending ☐ Submission Planned in Near Future ☐ *Transfer of Support

Project/Proposal Title: **Oral Tumor-anchored Bleomycin Therapy (PI: S. Li)**

Source of Support: **NIH NIDCR (R21 DE016025)**
Total Award Amount: $ **300,000** Total Award Period Covered: **07/01/04 - 06/30/06**
Location of Project: **Louisiana State University, Baton Rouge, LA**
Person-Months Per Year Committed to the Project. Cal:**0.00** Acad: **0.45** Sumr: **0.00**

Support: ☒ Current ☐ Pending ☐ Submission Planned in Near Future ☐ *Transfer of Support

Project/Proposal Title: **Q-TOF LC-MS for Proteomics and Biological Chemistry (PI: Hammer)**

Source of Support: **NIH NCRR(S10 RR017589)**
Total Award Amount: $ **500,000** Total Award Period Covered: **05/01/03 - 04/30/04**
Location of Project: **Louisiana State University, Baton Rouge, LA**
Person-Months Per Year Committed to the Project. Cal:**0.00** Acad: **0.00** Sumr: **0.00**

Support: ☐ Current ☒ Pending ☐ Submission Planned in Near Future ☐ *Transfer of Support

Project/Proposal Title: **Peptide Design with Tetrasubstituted Amino Acids (PI: Hammer)**

Source of Support: **National Science Foundation/CHEMISTRY**
Total Award Amount: $ **469,837** Total Award Period Covered: **07/01/04 - 06/30/07**
Location of Project: **Louisiana State University**
Person-Months Per Year Committed to the Project. Cal:**0.00** Acad: **0.00** Sumr: **1.00**

Support: ☐ Current ☒ Pending ☐ Submission Planned in Near Future ☐ *Transfer of Support

Project/Proposal Title: **Acquisition of a Light Scattering System for Research and Education at the Polymer/Colloid Interface (PI: Paul Russo)**

Source of Support: **National Science Foundation/MRI Program**
Total Award Amount: $ **171,165** Total Award Period Covered: **07/01/04 - 06/30/05**
Location of Project: **Louisiana State University**
Person-Months Per Year Committed to the Project. Cal:**0.00** Acad: **0.00** Sumr: **0.00**

Support: ☐ Current ☐ Pending ☐ Submission Planned in Near Future ☐ *Transfer of Support

Project/Proposal Title:

Source of Support:
Total Award Amount: $ Total Award Period Covered:
Location of Project:
Person-Months Per Year Committed to the Project. Cal: Acad: Summ:

---

*If this project has previously been funded by another agency, please list and furnish information for immediately preceding funding period.

USE ADDITIONAL SHEETS AS NECESSARY

Current and Pending Support
(See GPG Section II.D.8 for guidance on information to include on this form.)

The following information should be provided for each investigator and other senior personnel. Failure to provide this information may delay consideration of this proposal.

Investigator: Robin L. McCarley	Other agencies (including NSF) to which this proposal has been/will be submitted.

Support: ☒ Current   ☐ Pending   ☐ Submission Planned in Near Future   ☐ *Transfer of Support

Project/Proposal Title:

Stabilized Molecular Assemblies

CHE-0108961, PI

Source of Support: NSF-Analytical and Surface

Total Award Amount: $364K   Total Award Period Covered: 08/01/01-07/31/04

Location of Project: LSU

Person-Months Per Year Committed to the Project.   Cal: Acad: Sumr: 1

Support: ☒ Current   ☐ Pending   ☐ Submission Planned in Near Future   ☐ *Transfer of Support

Project/Proposal Title:

Micro-Instrument Platforms for Genetic-Based Analyses

R24 CA842625, Soper, PI

Source of Support: NIH NCI

Total Award Amount: $2,883,730   Total Award Period Covered: 4/1/00-3/31/05

Location of Project: LSU

Person-Months Per Year Committed to the Project.   Cal: Acad: Sumr: 1

Support: ☒ Current   ☐ Pending   ☐ Submission Planned in Near Future   ☐ *Transfer of Support

Project/Proposal Title:

Microsampling Unit for Capturing Low Abundant Cells and their Intracellular Analysis

1R21CA099246, Soper, PI

Source of Support: NIH NCI

Total Award Amount: $1,108,458   Total Award Period Covered: 5/01/03-4/30/07

Location of Project: LSU

Person-Months Per Year Committed to the Project.   Cal: Acad: Sumr: 1

Support: ☒ Current   ☐ Pending   ☐ Submission Planned in Near Future   ☐ *Transfer of Support

Project/Proposal Title:

Inhibition of Fibrillogenesis with Beta-Strand Mimics

R01 AG17983-01, Hammer, PI

Source of Support: NIH NIA

Total Award Amount: $1.2 M   Total Award Period Covered: 04/01/00-03/31/04

Location of Project: LSU

Person-Months Per Year Committed to the Project.   Cal: Acad: Sumr:

Support: ☒ Current   ☐ Pending   ☐ Submission Planned in Near Future   ☐ *Transfer of Support

Project/Proposal Title:

Modular Microfluidic Systems for Automated DNA Sequence Analysis

2R01HG001499, Soper, PI

Source of Support: NIH NHGRI

Total Award Amount: $1,535,473   Total Award Period Covered: 07/01/03-06/30/06

Location of Project: LSU

Person-Months Per Year Committed to the Project.   Cal: Acad: Sumr:

*If this project has previously been funded by another agency, please list and furnish information for immediately preceding funding period.

USE ADDITIONAL SHEETS AS NECESSARY

Current and Pending Support
(See GPG Section II.D.8 for guidance on information to include on this form.)

The following information should be provided for each investigator and other senior personnel. Failure to provide this information may delay consideration of this proposal.

Investigator: Robin L. McCarley	Other agencies (including NSF) to which this proposal has been/will be submitted.

Support: ☒ Current ☐ Pending ☐ Submission Planned in Near Future ☐ *Transfer of Support

Project/Proposal Title:

Development of Self-Study Preparatory Digital Videos for Analytical Chemistry Laboratories at LSU

SG-01-084, PI

Source of Support: The Dreyfus Foundation

Total Award Amount: $130,091   Total Award Period Covered: 8/01/01-1/31/04

Location of Project: LSU

Person-Months Per Year Committed to the Project.   Cal: Acad: Sumr:

Support: ☒ Current ☐ Pending ☐ Submission Planned in Near Future ☐ *Transfer of Support

Project/Proposal Title:

Analytical Enhancement of the Organic Chemistry Laboratories

Nauman, PI

Source of Support: Louisiana State University Technology Fee

Total Award Amount: $192,550   Total Award Period Covered: 3/1/02-6/30/04

Location of Project: LSU

Person-Months Per Year Committed to the Project.   Cal: Acad: Sumr:

Support: ☐ Current ☒ Pending ☐ Submission Planned in Near Future ☐ *Transfer of Support

Project/Proposal Title:

Acquisition of a Light Scattering System for Research and Education at the Polymer/Colloid Interface

(This application)

Source of Support: NSF-DMR

Total Award Amount: $171,165   Total Award Period Covered: 06/01/2004-05/31/05

Location of Project: LSU

Person-Months Per Year Committed to the Project.   Cal: Acad: Sumr:

Support: ☐ Current ☐ Pending ☐ Submission Planned in Near Future ☐ *Transfer of Support

Project/Proposal Title:

Source of Support:

Total Award Amount: $ Total Award Period Covered:

Location of Project:

Person-Months Per Year Committed to the Project.   Cal: Acad: Sumr:

Support: ☐ Current ☐ Pending ☐ Submission Planned in Near Future ☐ *Transfer of Support

Project/Proposal Title:

Source of Support:

Total Award Amount: $ Total Award Period Covered:

Location of Project:

Person-Months Per Year Committed to the Project.   Cal: Acad: Sumr:

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*If this project has previously been funded by another agency, please list and furnish information for immediately preceding funding period.

USE ADDITIONAL SHEETS AS NECESSARY

H. FACILITIES, EQUIPMENT AND OTHER RESOURCES

Laboratory: The Department of Chemistry shares Choppin Hall, a 7 story (plus basement) research and teaching building, with the biochemistry portion of the Department of Biological Sciences (Chemistry has about 80% of the building space). Bench and desk space for graduate and undergraduate students is available within faculty laboratory space. All the laboratories are fully equipped (hoods, facilities, etc.) for all chemical work proposed in this application.

Computer: Macintosh and PC computers are available within the laboratories and offices, including all necessary peripherals such as printers, internet access, scanner, and software. LSU has extensive computer resources with approximately 400+ open access PC computers for student use. On the research side there is a brand new 1024 node Beowolf Cluster for intensive parallel computing applications, along with an IBM SP cluster (see description of Super-Mike). The Macromolecular Computing Analysis Facility, located in Choppin Hall, has two modern Silicon Graphics Octane^2 workstations with molecular modeling and quantum programs available for chemistry applications. The Department of Chemistry has one full time computer support person and shares another support person with the College of Basic Sciences. A completely new 100 Mb/sec building-wide network was installed in 2001, which was designed to be easily up-graded to Gb/sec networking. LSU is also part of the Internet2 research network.

Office: Adequate office space is available for faculty and students in Choppin Hall. Laboratory design permits students to have a desk in laboratory safe-spaces, distant from chemicals, equipment, and other hazards. All faculty offices in Choppin Hall are equipped with a phone line and two to four 100 Mb/sec network connections. The research laboratories are also equipped with at least four 100 Mb/sec network connections.

Other: Chemistry departmental business matters are handled, free of charge, in a fully equipped and professional business office (232 Choppin Hall). Purchasing and personnel matters are also dealt with, free of charge, by a professional staff within the Department. Full secretarial backup is also provided free of charge. Within the College, situated in Choppin Hall, there are four support units including an Electronics Shop, Drafting Shop, Machine Shop and Glassblowing Shop. These units employ ten full-time staff members. Additional details on the shops appear near the bottom of the Project Description.

Within the LSU Department of Chemistry and Other Units: Over the past few years the Departments of Chemistry, Biochemistry, Physics and other units within the College of Basic Sciences, with funds from LEQSF, NSF, and NIH grants, have developed a number of facilities to support and enhance teaching and research efforts in the sciences. All instrumentation has full-time staff to serve as the primary instrument operators and day-to-day facility supervisors. These facilities include:

Nuclear Magnetic Resonance (NMR): There are four solution NMR spectrometers: Bruker 250, 300, 400 and 500 MHz with multinuclear direct and inverse probes for NMR analyses of a variety of nuclei, and variable temperature capability (-100 to +60 °C) on three instruments. The 250 and 400 MHz instruments were completely upgraded in 1999 with new computers, electronics, and probes from a major NSF Instrumentation Grant. The Department of Chemistry also has a dedicated solid-state 400 MHz Chemagnetics NMR spectrometer which is being upgraded to a Bruker system with another NSF CRIF grant. This facility is managed on a full time basis by a Ph.D. NMR spectroscopist, Dr. Dale Treleaven and a Master's scientist, Mr. Guangyu Li. Both have considerable experience in biological NMR and structure determination.

Mass Spectrometry: The Mass Spectrometry Facility provides analytical support for

the chemistry department and other academic departments at LSU, researchers at other universities, and customers from private industry. The facility offers a broad range of services with five mass spectrometers, which include: a Hewlett Packard 5971A GC/MS for routine GC separations and electron ionization (EI) mass spectrometry of semi-volatiles; Bruker ProFLEX III mass spectrometer used for mass analysis of synthetic and bio-polymers; a Perkin Elmer ELAN 6000 ICP-MS, used for trace metal analysis; a double focusing high resolution Finnigan MAT 900, with electron, chemical, FAB, and electrospray ionization sources and a PATRIC array detector, usually used for low resolution FAB and electrospray, but also used for high resolution accurate mass measurements. A new ABI QSTAR with MALDI and various spray sources in currently being installed (NIH SRI grant) and will greatly aid in MS/MS analyses of synthetic peptides. The facility is managed on a full time basis by two expert Ph.D. mass spectrometrists, Dr. Tracy McCarley and Dr. Michelle Beeson. Prof. K. Murray in the LSU Department of Chemistry operates several MALDI-TOF instruments in his research laboratories and is developing new MALDI techniques including infrared and new matrix desorption methods.

X-ray Crystallography: This outstanding facility includes two modern Nonius diffractometers: a CAD4 with a copper X-ray tube and a new Kappa CCD diffractometer with a state-of-the-art cryogenic apparatus for performing low-temperature X-ray structures. The facility is thus equipped to optimally handle both organic and inorganic compounds. The facility has a dedicated Digital Equipment Corporation (DEC) Alpha 255/300 workstation and several Pentium PCís for structure solving and refinement. Both the Nonius MOLIN and Bruker SHELXTL program packages, which are interactive and quite easy to use, are available for solving structures. This facility is managed on a full time basis by an expert Ph.D. crystallographer, Dr. Frank Fronczek. The availability of rapid crystal structure determinations by single-crystal X-ray diffraction methods has established LSU as a leader in structural chemistry in the United States. A new Bruker Advance powder diffractometer is also available through Prof. J. Chan.

Polymer Analysis Laboratory (PAL): In addition to the light scattering equipment described in the Project Description, PAL's thermal analysis facility includes differential scanning calorimetry (DSC, three instruments), simultaneous thermogravimetric/differential thermal analysis (TGA/DTA, two instruments), steady state and oscillatory thermomechanical analysis (TMA), and dynamic mechanical spectroscopy (DMS). Thermally stimulated changes in dielectric properties (DEA) can also be measured. New DSC, TGA and DEA analyzers were recently added to the facility. The DSC has adequate sensitivity for many polymer solutions, as well as bulk polymers. PAL's optical microscopy facility is equipped for polarized, Normarski, transmission, and epi-fluorescence illumination, as well as confocal mode for "optical sectioning" of materials in three dimensions. A special apparatus for fluorescence photobleaching recovery combines laser illumination and computer-interfaced photometry to measure diffusion rates in solutions, gels, melts, and liquid crystals. Film and video cameras interface to two separate image-processing systems. A new QuantaChrome Autosorb-1 gas sorption system is also available for measuring surface areas (BET) on polymer and other materials. A small angle X-ray scattering device, supported by NSF-IGERT and constructed in part by IGERT fellows, is undergoing final testing at CAMD, a compact synchrotron storage ring (see below).

Microscopy Facility: The Socolofsky Microscopy Center is administered through the Department of Biological Sciences and the College of Basic Sciences. The Center maintains and facilitates use of a number of microscopes including: Nikon Microphot Light Microscope, (which has bright field, phase contrast, fluorescence, differential interference contrast, and polarization optics capabilities, and a SPOT RT digital camera); Noran Laser Scanning Confocal Microscope with Silicon Graphics digital imaging; Cambridge Stereoscan 260 Scanning Electron Microscope with photographic and digital imaging capabilities; and a JEOL 100-CX Transmission Electron Microscope with photographic imaging. Specimen preparation instrumentation includes critical point dryers, sputter coaters, vacuum evaporators, knife

makers, ultramicrotomes, etc. It is located in the Life Sciences Building (rooms 24, 25, 27, 30 and 31) and currently employs two full-time research associates to assist users with microscopy and imaging projects (Cindy Henk and Ying Xiao).

Protein Facility: The Protein Facility located in Choppin Hall contains the following equipment: an Applied Biosystems Pioneer peptide synthesizer with Multiple Peptide System attachment; HPLC systems: Waters 600 E, Waters Delta Prep, Waters 600S/PDA detector; a Beckman P/ACE 5510 Capillary Electrophoresis; a Beckman XL-A Analytical Ultracentrifuge; an Aviv Circular Dichroism Spectrophotometer; a Dionex AAA-Direct Amino Acid Analyzer; and accessory equipment: a Wheaton Autostill, a rotary evaporator, a Paar Density Meter, a Labconco Freeze-drier, and a Savant Speed Vac. The facility is operated by a full-time Research Associate, Ms. Martha Juban and is located in Choppin 439. Dr. Hammer's research group has direct access to the peptide synthesizer in the laboratory.

Parallel Computing: Super Mike: In an effort to significantly enhance the high-performance-computing resources that are available to Louisiana's students and academic researchers in various subfields of information technology, LSU has acquired through Atipa Technologies a Beowulf-class supercomputer with 1,024 Intel® 1.8 GHz Xeon DP processors that are tightly coupled through Myricom's myrinet network. The system contains 1 Terabyte of RAM and more than 40 Terabytes of disk storage. It has been christened, "SuperMike" (supermike.lsu.edu).

According to the standard HPL (High Performance Computing Linpack) benchmark that is used to rank the performance of supercomputers worldwide, "SuperMike" clocks at 2.207 TeraFlops; that is, it performs over 2 trillion floating point operations every second. At the end of August, 2002, when this benchmark result was submitted to Top500.org for verification, it became clear that LSU had acquired the 11th fastest supercomputer in the world! Among academic institutions worldwide, LSU's new system ranks second only to a system that resides at the federally funded, Pittsburgh Supercomputer Center.

Center for Advanced Microstructures and Devices (CAMD): CAMD is a $25M high-tech synchrotron (compact electron storage ring) research center whose role is to provide equipment, expertise, and infrastructure for research and development in the area of microstructures and microdevices. CAMD is housed in a 45,000 square-foot building located on a 15-acre site approximately five miles from the LSU campus. Current investigations at CAMD focus on basic research in the areas of atomic and molecular structure and condensed-matter (surface and bulk phase) phenomena and applied research in the exciting field of microdevice fabrication. Additionally, CAMD is a center where X-ray spectroscopy and microscopy is being used to provide powerful analytical tools for materials research, industry, and the environment. There are 4 micromachining beam lines, 4 vacuum UV and soft X-ray beam lines, and 4 "hard" X-ray beam lines. A dedicated protein crystallography station is the newest addition to the "hard" X-ray beam section.

Quotation S14509A

Date   22 December 2003

Malvern Instruments, Inc.
10 Southville Road
Southborough MA 01752
Telephone: (508) 480-0200
Fax: (508) 460-9692
info@malverninstruments.com
www.malverninstruments.com

TO

Louisiana State University
Department of Chemistry, 232 Choppin Hall
Baton Rouge, LA 70803
Attn: Paul Russo / Tel: 225-578-5729
Email: chruss@lsu.edu

WE ARE PLEASED TO QUOTE YOU AS FOLLOWS   YOUR INQUIRY

FOB	TERMS	PRICES GOOD FOR	ESTIMATED DELIVERY
Southborough, MA	Net 30 days	**December 31, 2003**	4 – 6 weeks / ARO

QTY.	DESCRIPTION	AMOUNT
	ZEN3600, Zetasizer Nano ZS size for molecular weight and zeta potential measurement **ZEN3600,** Zetasizer Nano-ZS for the measurement of size, molecular weight and zeta potential of dispersed particles and molecules in solution. Includes 4mW 633 He-Ne laser. (Measurement in non-polar liquids requires universal cell option P/N ZEN1002) Temperature range 2deg.C minimum, 90deg.C maximum (70deg.C maximum with disposable DTS1060 cell) **Size range**: 0.6nm to 6microns. Size range for zeta potential 3nm to 10microns Concentration range for size measurement 0.1ppm to 40wt% maximum Molecular weight range: 1x10E3 to 2x10E7 Requires but does not include computer, only compatible with Windows 2000 and XP operating systems.	$ 53,760.00
	CPH2060, DELL Optiplex GX270 Mini Tower Computer with Windows 2000 / SP4, 2.26 GHz Intel Pentium IV Processor with 512K Cache, 256Mb RAM, 80Gb HDD, 48 x CD-RW, 3.5" 1.44MD Floppy Drive, complete with Mouse, Keyboard, Internal V.92 PCI Modem and 15" LCD flat panel color Moniter. Includes a minimum of 1 serial port and a minimum of 1 full-length PCI slot. 10/100/1000 Intel NIC card.	$ 1,380.00
	CPP2040 - Printer Hewlett Packard model number 6127.	$ 220.00
	DTS2145, Low-volume 45 microlitre cuvette for use with the HPPS	$ 450.00
	Complete Particle Size Analysis System including end user Training	$ 55,810.00
	Less Discount	($ 2,790.50)
	Final Price	$ 53,019.50
	Note: The Malvern Zetasizer Nano system comes complete with an on-site training visit by an application expert. The system is designed to be plug and play, and includes a QuickStart Manual and standards for those users wishing to install and validate the system themselves. Many of our customers choose this option, which allows for more focus on application and data interpretation during the training visit. If preferred however, the installation can be performed during the training visit.	

SIGNATURE: *Robert W. Feczko*

Quotation S14509A

22 December 2003

TO

Louisiana State University
Department of Chemistry, 232 Choppin Hall
Baton Rouge, LA 70803
Attn: Paul Russo / Tel: 225-578-5729
Email: chruss@lsu.edu

WE ARE PLEASED TO QUOTE YOU AS FOLLOWS   YOUR INQUIRY

FOB	TERMS	PRICES GOOD FOR	ESTIMATED DELIVERY
Southborough, MA	Net 30 days	**December 31, 2003**	4 – 6 weeks / ARO

QTY.	DESCRIPTION	AMOUNT
	Optional at additional cost: One year Extended Warranty Plan (EWP), Plan is available in multi-year terms **EWP** to cover Malvern Instrument for second year	**$ 3,350.00**
	ZEN1001, MPT-2 Multi- purpose titrator supplied as a separate unit. For the automation of size, zeta potential or intensity measurements as a function of pH, conductivity or additive concentration. Compatible with: Zetasizer Nano S, Z, ZS and ZS90 (Note ZS90 for automated zeta potential only) Includes: 3 titrant dispensing unit, connecting tubing, reaction containers, consumables kit, software and manual. Cost of Installation is not included. Installation can be done on site by a Malvern trained engineer. Note 1: Automated measurement of size and zeta potential with the Zetasizer Nano series requires the folded capillary cell (DTS1060)	**$ 9,920.00**
	ZEN1002, Universal 'dip' cell kit for samples in aqueous and non-aqueous, i.e. non-polar dispersants such as hydrocarbons. Compatible with PCS1115 cuvettes.. Includes electrode assembly with Palladium electrodes with 2mm spacing and one PCS1115 cuvette and cap. Compatible with all Nano series systems that measure zeta potential.	**$ 2,560.00**

SIGNATURE: *Robert W. Feczko*
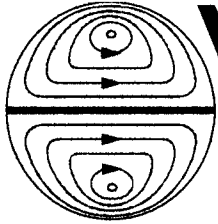
Wyatt Technology CORPORATION

30 South La Patera Lane, B-7 • Santa Barbara, CA 93117
TEL (805) 681-9009 • FAX (805) 681-0123
E-mail: info@wyatt.com • URL http://www.wyatt.com

Sales Quotation

We are pleased to present this quotation to:

Paul Russo
Louisiana State University
Choppin Hall
Dept. of Chemistry
Baton Rouge, LA 70803
Phone: (225)578-5729
Fax: (225)578-3458

Date 12/2/2003
Quote Number: 006073
Quote Expires on: 3/1/2004
Questions? Please call Cliff Wyatt

Part #	Description	Price	Qty	Extend	
DAWN EOS	30mW diode laser light source, 18 angle, digital signal processing (DSP) light scattering detector. ASTRA Windows-based data collection and analysis program for HPLC light scattering that determines Number, Weight and Z-average molecular weights and rms sizes and their distributions.	$55,499.00	1	$55,499.00	✓
EOS High Temp Option	High temperature regulation for the read head that permits control of the cell from approximately ambient to 150°C (±0.1°C). One meter long temperature-controlled dual line tubing is provided.	$15,999.00	1	$15,999.00	✓
OPTILAB DSP	INTERFEROMETRIC REFRACTOMETER For on or off-line use at 690nm (other wavelengths available on special order). The Optilab comes pre-calibrated.	$19,000.00	1	$19,000.00	✓
Wyatt Viscolab	4-capillary differential viscometer provides a direct measurement of intrinsic viscosity from 0 to 50 degrees C, built in computer, Capillary Dimensions 0.01" ID x 24"L,Sample shear rate 3000 Hz,Cell volume 80 uL, 2 programmable output signals. Each can be either absolute pressure, relative pressure, or relative viscosity, USB communications with host computer, Universal power input 80-260VAC 50-60Hz, LCD front panel control including button array for menu navigation.	$25,000.00	1	$25,000.00	✗

Part #	Description	Price	Qty	Extend	
900004-DNDC Kit	To make great dn/dc measurements you need a super-stable system because even small differences in refractive index will be detected by the Optilab. Comes with an injection valve, loop, peek tubing, 5 syringes and an adapter.	$999.00	1	$999.00	✓
Wyatt Viscolab	4-capillary differential viscometer provides a direct measurement of intrinsic viscosity from 0 to 50 degrees C, built in computer, Capillary Dimensions 0.01" ID x 24"L,Sample shear rate 3000 Hz,Cell volume 80 uL, 2 programmable output signals. Each can be either absolute pressure, relative pressure, or relative viscosity, USB communications with host computer, Universal power input 80-260VAC 50-60Hz, LCD front panel control including button array for menu navigation.	$25,000.00	1	$25,000.00	✗
WyattQELS System	On-line Quasi-Elastic Light Scattering (QELS) system (aka Dynamic Light Scattering (DLS)) that interfaces to the Wyatt Technology detector. Can be used to determine particle sizes as small as 1nm. Includes DAWN-to-digital autocorrelator interfacing via the optical fiber. Comes with QELSBatch software intended for the analysis of QELS data from unfractionated samples. It uses two different industry-standard algorithms to assess the polydispersity of your sample. The first is the time-tried method of cumulant analysis and the second is regularization analysis. Requires a Pentium class PC with 1 USB connector and Windows 98/2000/XP (it will NOT work with Windows NT).	$24,000.00	1	$24,000.00	✓
Wyatt COMET	Cell Operation and Maintenance-Enhancing Technology device (900065). Connects to your existing flow cell manifolds to apply a radio frequency ultrasonic field to minimize particulate adhesion to the flow cell windows and through-bore. Compatible with the DAWN DSP, DAWN EOS, miniDAWN and miniDAWN Tristar instruments.	$2,499.00	1	$2,499.00	✓

Part #	Description	Price	Qty	Extend	
900002-2-Organic-Chrom Filter	The Filter Kit contains all necessary parts to install an in-line filter after your HPLC pump, including the filter holder. It helps prolong the life of your columns, reduces the cell cleaning frequency, and improves your light scattering baselines. This kit is a "must" for any serious light scattering chromatographer. Specify one of the following three filters: - Hydrophobic PVDF, 0.2 um (for organic, but NOT for acetone, DMAc, DMF, DMSO)	$950.00	1	$950.00	X
900001-21 Ambient Cleaning	Ambient Cell Cleaning Kit is something all DAWN and miniDAWN users need. The soft tip, reversed tweezers are perfect for handling our delicate cell windows; the lens tissue is the best available on the market; and the wrist strap prevents static electricity buildup that can attract charged dust particles from coming back.	$325.00	1	$325.00	X
900003-Microbatch Filter Kit	When you calibrate your DAWN, flush the flow cell, or perform Microbatch experiments, you need all the items in this Kit to ensure your success. The disposable syringes are compatible with most solvents, the luer adapter and union make it easy to connect the tubing to the syringes, and the syringe tip filters have the smallest pore size available to prevent contamination of the flow cell.	$200.00	1	$200.00	X
Training	Three days of training in Santa Barbara are included with the purchase of a DAWN EOS and or a miniDAWN instrument by a U.S. customer. Airfare to/from Santa Barbara is included for one person (Saturday night stayover required) from anywhere in North America.	$0.00	1	$0.00	FREE
Technical Support	Unlimited free telephone, e-mail and FAX support for one year (Value to $200.00 per hour).	$0.00	1	$0.00	FREE
	Less 15% Academic discount			($25,420.65)	

Part #	Description	Price	Qty	Extend

TERMS: Net 15 days
DELIVERY: 30-60 days ARO
SHIPPING: All shipping costs to be borne by the buyer.

TOTAL WEIGHT 156.00

Sub-Total	$144,050.35
Tax	
Total	**$144,050.35**

RETURNS: Unauthorized returns will not be accepted. All returns must have our prior approval, a Return authorization Number, and a copy of our invoice and packing list. Returned goods are subject to a 15% restocking charge. Return goods must be returned with shipping charges prepaid. All returned merchandise must be returned in new condition in its original shipping containers. No goods are eligible for return more than 30 days after receipt by the customer.

COMPUTER REQUIREMENTS: Intel Pentium, or compatible, 10+ Gbyte hard drive, 256M RAM, 17" monitor suggested, Windows 2000 or later.

WARRANTY: All instruments manufactured by Wyatt Technology are warranted to be free from defects in materials and/or workmanship for a period of twelve (12) months from the date of acceptance. Certain OEM items are warranted by their manufacturers, and those warranties may be different from Wyatt Technology's warranty policy. All prices quoted are FOB Santa Barbara, California, and are subject to change without notice. Wyatt Technology makes no warranties, either express or implied, regarding their instruments or computer software packages, their merchantability or their fitness for any particular purpose.

TERMS AND CONDITIONS

The following Terms and Conditions are to be construed and interpreted simply and fairly and not for or against either the BUYER or the SELLER.

CLAIMS FOR DAMAGES

Claims for damages or shortages must be made within 10 days of receipt. We hereby certify that these goods were produced in compliance with all applicable requirements of section 6,7 and 12 of the Fair Labor Standards Act as amended, and of regulations and orders of the United States Department of Labor issued under section 14 thereof.

DELIVERY

Every reasonable effort will be made to deliver as promised. However, SELLER is not liable for nonperformance, delay, loss of damage to items, in whole or in part caused by an act of God, or the public enemy, or by labor troubles, lockouts, strikes, riots, fires, storms, explosions, breakdowns of machinery, railroad embargoes, government interventions, acts of war or other causes affecting it or its sources of supply. In the event of a delay caused by any of the fore-going, BUYER agrees to extend the time of delivery for a period equal to the period of delay.

If the BUYER delays performance or shipment, the items shall be paid for when they are ready to be shipped.

SECURITY INTEREST AND RETAKING

To secure the payment of the purchase price BUYER hereby grants to SELLER a security interest in the items and all accessories, substitutions, additions or replacements. BUYER agrees to execute a UCC 1 Form and/or any and all papers that may be desirable, by SELLER, to carry out the terms, intention or purpose of this agreement after the offer is accepted. In the event BUYER fails to pay the purchase price SELLER shall be at liberty and is hereby authorized to enter premises where the items may then be and take same either with or without legal process but without breach of the peace. Upon any such retaking, SELLER shall have the right to resell, for the account of BUYER, at a private sale or otherwise, without notice to BUYER and may, upon such resale, become the purchaser of such goods. Upon such resale, the proceeds shall be applied to the payment of expenses of retaking and resale and then to the payment of the purchase price remaining due from BUYER. In the event that after such application of proceeds of resale a deficiency arises BUYER shall pay such deficiency.

In the event that after applying the proceeds of sale to the expenses of retaking and resale and the balance due a surplus exists, such surplus shall be paid to BUYER.

WAIVER OF DEFENSES

Buyer hereby waives the right to assert against SELLER's assignee, any defense, counterclaim, set-off or claim, known or unknown, which BUYER could assert against SELLER in an action brought by SELLER upon the debt of BUYER.

ATTORNEY FEES

In the event that any proceeding shall be brought to enforce or to interpret this agreement, BUYER agrees to pay all of SELLER's court costs and reasonable attorney fees incurred including its reasonable attorney fees and court costs incurred in enforcing any judgement obtained. BUYER further agrees to pay SELLER's actual costs and expenses, including reasonable attorney fees if SELLER refers BUYER's account to an attorney for collection, whether or not suit is filed, but only if the seller prevails.
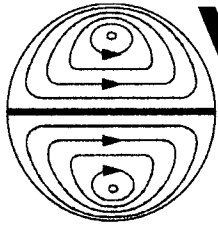
ARBITRATION

Except for any proceeding brought by SELLER to collect any payment due from BUYER, any controversy or claim arising out of, or relating to the goods sold or services rendered hereunder, or any breach hereof, shall be settled by arbitration in Santa Barbara, California, in accordance with the Commercial Arbitration Rules of the American Arbitration Association. Judgement upon the award rendered by the arbitrator may be entered in any court having jurisdiction thereof. Neither party shall be entitled to an award of attorney fees if the matter is arbitrated.

AMENDMENT

No verbal agreement nor any change or amendment hereof will be considered binding on SELLER unless so agreed in writing.

WYATT TECHNOLOGY CORPORATION

Cliff Wyatt

Wyatt Technology CORPORATION

30 South La Patera Lane, B-7 • Santa Barbara, CA 93117
TEL (805) 681-9009 • FAX (805) 681-0123
E-mail: info@wyatt.com • URL http://www.wyatt.com

Sales Quotation

.We are pleased to present this quotation to:

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Baton Rouge, LA 70803
Phone: (225)578-5729
Fax: (225)578-3458

Date 12/2/2003
Quote Number: 006074
Quote Expires on: 3/1/2004
Questions? Please call Cliff Wyatt

Part #	Description	Price	Qty	Extend	
AFFF System	Eclipse Asymmetric Field Flow Fractionator system includes: separation channel; computer controlled outlet valves for regulating cross flow rate; electronic valves for switching among elution, focusing and flush mode; on-line vacuum degasser; isocratic pump to deliver channel flow; pump for sample injection; Rheodyne 7725i injection valve; software for control of valves and pumps. Please note that your PC must include 3 free serial ports. Includes 100 uL injector loop volume.	$59,999.00	1	$59,999.00	✓
AFFF organic channel Option	Eclipse Asymmetric Field Flow Fractionator separation channel compatible with some organic solvents e.g. THF and Toluene.	$12,000.00	1	$12,000.00	✓
On-site training	3 days of training at the customer's laboratory.	$6,500.00	1	$6,500.00	✗
Technical Support	Unlimited free telephone, e-mail and FAX support for one year (Value to $200.00 per hour).	$0.00	1	$0.00	free
	Less Academic Discount	($8,174.00)	1	($8,174.00)	

Sub-Total	$70,325.00
Tax	
Total	$70,325.00

TERMS: Net 45 days
DELIVERY: 30 days ARO
SHIPPING: All shipping costs to be borne by the buyer
SHIPPING WEIGHT: 100.00

RETURNS: Unauthorized returns will not be accepted. All returns must have our prior approval, a Return authorization Number, and a copy of our invoice and packing list. Returned goods are subject to a 15% restocking charge. Return goods must be returned with shipping charges prepaid. All returned merchandise must be returned in new condition in its original shipping containers. No goods are eligible for return more than 30 days after receipt by the customer.
COMPUTER REQUIREMENTS: Intel Pentium, or compatible, 10+ Gbyte hard drive, 256M RAM, 17" monitor suggested, Windows 2000 or later.

WARRANTY: All instruments manufactured by Wyatt Technology are warranted to be free from defects in materials and/or workmanship for a period of twelve (12) months from the date of acceptance. Certain OEM items are warranted by their manufacturers, and those warranties may be different from Wyatt Technology's warranty policy. All prices quoted are FOB Santa Barbara, California, and are subject to change without notice. Wyatt Technology makes no warranties, either express or implied, regarding their instruments or computer software packages, their merchantability or their fitness for any particular purpose.

TERMS AND CONDITIONS

The following Terms and Conditions are to be construed and interpreted simply and fairly and not for or against either the BUYER or the SELLER.

CLAIMS FOR DAMAGES

Claims for damages or shortages must be made within 10 days of receipt. We hereby certify that these goods were produced in compliance with all applicable requirements of section 6,7 and 12 of the Fair Labor Standards Act as amended, and of regulations and orders of the United States Department of Labor issued under section 14 thereof.

DELIVERY

Every reasonable effort will be made to deliver as promised. However, SELLER is not liable for nonperformance, delay, loss of damage to items, in whole or in part caused by an act of God, or the public enemy, or by labor troubles, lockouts, strikes, riots, fires, storms, explosions, breakdowns of machinery, railroad embargoes, government interventions, acts of war or other causes affecting it or its sources of supply. In the event of a delay caused by any of the fore-going, BUYER agrees to extend the time of delivery for a period equal to the period of delay.

If the BUYER delays performance or shipment, the items shall be paid for when they are ready to be shipped.

SECURITY INTEREST AND RETAKING

To secure the payment of the purchase price BUYER hereby grants to SELLER a security interest in the items and all accessories, substitutions, additions or replacements. BUYER agrees to execute a UCC 1 Form and/or any and all papers that may be desirable, by SELLER, to carry out the terms, intention or purpose of this agreement after the offer is accepted. In the event BUYER fails to pay the purchase price SELLER shall be at liberty and is hereby authorized to enter premises where the items may then be and take same either with or without legal process but without breach of the peace. Upon any such retaking, SELLER shall have the right to resell, for the account of BUYER, at a private sale or otherwise, without notice to BUYER and may, upon such resale, become the purchaser of such goods. Upon such resale, the proceeds shall be applied to the payment of expenses of retaking and resale and then to the payment of the purchase price remaining due from BUYER. In the event that after such application of proceeds of resale a deficiency arises BUYER shall pay such deficiency.

In the event that after applying the proceeds of sale to the expenses of retaking and resale and the balance due a surplus exists, such surplus shall be paid to BUYER.

WAIVER OF DEFENSES

Buyer hereby waives the right to assert against SELLER's assignee, any defense, couterclaim, set-off or claim, known or unknown, which BUYER could assert against SELLER in an action brought by SELLER upon the debt of BUYER.

ATTORNEY FEES

In the event that any proceeding shall be brought to enforce or to interpret this agreement, BUYER agrees to pay all of SELLER's court costs and reasonable attorney fees incurred including its reasonable attorney fees and court costs incurred in enforcing any judgement obtained. BUYER further agrees to pay SELLER's actual costs and expenses, including reasonable attorney fees if SELLER refers BUYER's account to an attorney for collection, whether or not suit is filed, but only if the seller prevails.

ARBITRATION

Except for any proceeding brought by SELLER to collect any payment due from BUYER, any controversy or claim arising out of, or relating to the goods sold or services rendered hereunder, or any breach hereof, shall be settled by arbitration in Santa Barbara, California, in accordance with the Commercial Arbitration Rules of the American Arbitration Association. Judgement upon the award rendered by the arbitrator may be entered in any court having jurisdiction thereof. Neither party shall be entitled to an award of attorney fees if the matter is arbitrated.

AMENDMENT

No verbal agreement nor any change or amendment hereof will be considered binding on SELLER unless so agreed in writing.

WYATT TECHNOLOGY CORPORATION

Cliff Wyatt

VISCOTEK

The Leader in Polymer Characterization

November 17, 2003   VCQ# 11172003

Dr. Rafael Cueto
Louisiana State University
Department of Chemistry, 232 Choppin Hall
Baton Rouge, LA 70803

Dear Dr. Cueto:

Viscotek is pleased to submit the following for your consideration:

P.N.	Description	Price
=============	===	=========
VE200102	**GPCmax Integrated Pump, Autosampler and Degasser**	$15,000
	LSU Academic Discount	($1,500)
	One Year Warranty, Including Parts and Labor	N/C
	Total	$13,500

Net 30
FOB Houston, PPD and ADD
Quotation valid for 90 days
Installation and training subject to permitted facility access

Sincerely,

Shawn Welch
Vice President, Sales and Marketing

Instruments for Materials Research Program
National Science Foundation
4201 Wilson Boulevard
Arlington, Virginia   22230

January 7, 2004

Re: Support for IMR proposal, *"Acquisition of a Light Scattering System for Research and Education at the Polymer/Colloid Interface"*

Dear Colleagues,

LSU is pleased to commit $73,357 (30%) in direct support of the proposal *"Acquisition of a Light Scattering System for Research and Education at the Polymer/Colloid Interface"* by Professors Paul Russo, Robin McCarley and Robert Hammer of our Chemistry Department. This group is addressing several challenging problems at the interface of materials chemistry and colloid science. The new instruments will enable, for the first time at LSU, assessment of charge on colloidal particles, polymers, proteins and aggregates. Also included is a Field Flow Fractionation device for separation of large particles with on-line analysis of size.

The main investigators and several auxiliary users from our interdepartmental Macromolecular Studies Group are well supported and active. Several of their students are NSF-IGERT fellows in LSU's unique *"Teaching Craft for Macromolecular Creativity"* program, and all IGERT fellows will receive training on the equipment through the core Macromolecular Studies curriculum. Undergraduate programs will also benefit, including an NSF-REU site founded by one of the co-PIs (Hammer) and now jointly operated by the departments of Chemistry, Chemical Engineering and Biological Sciences at LSU. The Macromolecular Studies Group works closely with other universities in Louisiana, and I note with satisfaction the inclusion of a young professor (David Norwood) from Southeastern Louisiana University in nearby Hammond, which is a primarily undergraduate institution. LSU auxiliary users include two promising young recipients of NSF CAREER awards. The requested instrumentation should be of interest to partners in industry, and the implementation plan includes an open house/minicourse on Field Flow Fractionation methods (the instrument would be the first in Louisiana and among the first of its kind to be placed in a US academic laboratory).

Finally, I wish to assure you that Materials Science and Engineering is high on the agenda in my office. With historically black Southern University and the University of New Orleans, we have submitted a Letter of Intent to offer interdisciplinary Ph.D. programs. That letter has been signed by the appropriate supervisory boards and now awaits final action by the Louisiana Board of Regents. Each university will have a mission in the overall effort, and it is clear that much of the macromolecular expertise will reside at LSU. Knowing that the requested instrumentation contributes to not only a university-wide effort, but also to education, research and training needs across the state, makes it easy to support this proposal in the strongest possible terms.

Sincerely,

Kevin M. Smith
Vice Chancellor for research and Graduate Studies
Dean of the Graduate School
LSU Foundation Distinguished Professor of Chemistry

c: Assistant Vice Chancellor Pourciau

December 12, 2003

To Whom It May Concern:

      Dow researchers at the Plaquemine, LA, Freeport, TX, and Midland, MI site have engaged in several collaborative efforts with Professor Russo and his students through a time spanning nearly 2 decades. This relationship has involved a variety of activities including hosting student researchers at our R&D locations, consulting, and specialized polymer characterization support. Because our Plaquemine site is located near the LSU, Baton Rouge, campus, it is convenient for us to schedule instrument time and Professor Russo has always been accommodating to our schedules and project needs. Dow operates a daily commuter shuttle between the Texas and Louisiana sites, making the major Gulf Coast operations of Dow accessible for all. In short, the Russo group has been a good friend and research partner with Dow and we consider the relationship mutually beneficial.

      We therefore enthusiastically support Professor Russo's efforts to acquire new analytical tools, especially for the support of polymer analysis. Dow R&D and business groups often out-source projects to university partners, and Professor Russo's labs have been used consistently for this purpose. His group provides needed expertise, and his labs are well-equipped to meet specialized polymer analysis needs. Also, Professor Russo is committed to improving and expanding the instrumentation and skill set in his group, which makes collaborating with him more attractive. We would consider ourselves secondary rather than primary users of the instrumentation requested in this proposal, scheduling time on an as-needed basis and working with Professor Russo on the details of the transaction on a case-by-case basis, as we have done many times before.

      We value the excellent university-industrial, collaborative relationship with LSU and Professor Russo, and encourage the reviewers of this proposal to consider the proposal, and more specifically, the instrumentation request, favorably.

Sincerely,

Drew Poché, Ph.D.
Dow R&D Analytical Sciences
Louisiana Operations
Plaquemine, Louisiana