UNIVERSITY TEACHING GRANTS

BUDGET

A. Costs to provide a replacement: $ 3,000
($4,000 maximum)

Teaching/Lab assistants to prepare and characterize samples

B. Supplies and Travel: $ 2,000
($2,000 maximum)

1. Supplies (please specify):

Chemicals and solvents	$ 500
Lab supplies	$ 700
Materials Characterization services	$ 400
	$
	$

2. Travel Costs (please specify):

American Chemical Society	$ 400
Chemical Education Division Meeting	$
April, 1993	$
	$
	$

TOTAL ($6,000 Maximum): $ 5,000

Table 1 Major Topics in a One Quarter (10 weeks)
Undergraduate Course, Introduction to Polymer Science and
Polymeric Materials (MSE 519)

Topic	Key Concepts	Conventional Materials/Methods	Gradient Materials (Phase I)
Polymer Applications	Wide range of Properties and compositions	Examples from consumer products and engineering devices & machines	None
Macro molecules	High molecular weights. packing, entanglement	Individual examples	MW gradients* comonomer gradients
Polymerization and copolymerization	Properties = f (composition, molecular weight)	Individual examples	MW gradients* comonomer gradients
Morphology and Structure	Packing, Ordering, Melting	Individual examples, molecular simulation	Crystallization, annealing, ordering as f (T, t), comp. gradients
Block copolymers	Phase separation, incompatibility	Blends, diblock - triblock - copolymers	Blend gradient*
Solubility and solutions	Solution Interactions and thermodynamics	Individual examples - MW, polarity, Temp.	Temp. gradient - LCST composition gradient
T - t Effects	T - t superposition; effect of properties on T and t	Specific examples	T gradient/comp. gradient
Cross-linking	Networks, elasticity, viscoelasticity	Individual examples	Cross link gradient; mechanical response
Additives	Plasticization	PVC - Plasticizer - individual samples	Plasticizer gradient, T gradient
Surface Properties	Wetting/surface modific.	Individual Examples	Wetting gradients, capillarity
Processing	Fiber formation, film molding	Thermoplastic, thermoset, T and processing	T gradient, cross link gradient composition gradient
Adhesives	Adhesion/surface properties	Hi and low energy polymers, contact angle, peel tests	Surface property gradient
Electrical fields	Conductivity, ionization, solubility	Mainly conductive polymers	Ionogenic polymers & biopolymers; electrically responsive polymers; T gradient; LCST; Elect. responsive
Biopolymers	structural proteins	Silk, collagen	Polypeptide gradients*
Environmental issues	Cost, energy, solid waste, biodegradation	Specific examples, classes, stability	Composition/morphology gradients; stability

* Follow on activities -- possibly via a grant from the National Science Foundation

The experiments for this proposal are based on two themes:

1) where possible, actual materials commonly utilized in common consumer products will be employed, and
2) a set of special materials will be developed which the students can utilize to directly see complex concepts.

In both cases, the experiments and observations will utilize only the students' senses for transduction and detection.

I expect to develop, produce, and characterize four different gradient materials in thin sheet forms suitable for the direct observation of a range of basic physical/chemical phenomena related to macromolecules.

Since so many of the properties of polymer materials are time and temperature dependent, it is almost mandatory to be able to produce different temperatures to permit such observations. A simple temperature gradient device used with gradient materials allows a wide range of relationships to be directly observed. A simple thermal gradient device powered by a flat battery similar to those used in Polaroid film packs, is easily constructed.

The materials and methods developed will be tested in the Spring of 1993 in the Materials Science and Engineering 519 Polymer Materials course taught by J. Andrade. This is the terminal polymer materials course for those majors who do not go on into the polymer science track.

Table 1 presents a typical topic outline for the Polymer Materials course. It presents the general topic, followed by a column of commercial or conventional polymer examples, followed by a column of the special materials I propose to develop in this project. The table indicates how the new materials and existing materials are used by students to discover and observe the various concepts, properties, and behavior.

I would like to initiate the project as soon as possible. Two seniors in Materials Science and Engineering will serve as the Lab assistants and begin preparing several of the gradient samples for evaluation and use in the W-93 course offering. By April, 1993, we should be in a position to submit a grant to the National Science Foundation for further development and assessment of the project.

A Lableless Lab in Polymer Materials

J.D. Andrade, P.I.

Undergraduate students in many science and engineering courses in the United States have little or no laboratory experience in such courses. The labless science and engineering course has become a very common feature in higher education. Although outstanding instructors attempt to overcome this deficiency with the use of classroom demonstrations, discovery based homework assignments, class projects, and computer simulations, many instructors may not have the time or inclination to utilize these tools, particularly in relatively large lecture environments. Labs are also not generally available for correspondence, distance learning, or TV/video delivered courses. I feel there is a need for small, inexpensive, completely self contained laboratories which can be supplements to existing textbooks.

This concept does not only apply to polymer materials, but indeed applies to all such labless technical courses. I feel strongly that many complex concepts can be observed and assimilated by experimentation with properly designed materials. I propose the development of materials and specimens designed specifically for teaching and learning purposes.

Nearly 3,000 colleges and universities in the United States teach a wide variety of science and technical courses. Virtually every one of them teaches several years of chemistry, physics, and biology. Freshman textbooks in Chemistry, for example, usually include a chapter on polymers and biopolymers. Physics and Biology texts often include chapters on the solid state and on biopolymers, respectively.

The several hundred undergraduate engineering programs in the country nearly all teach a course in materials science, with a significant polymer component, and many of them teach a separate course in polymer materials. There are of the order of 40,000 introductory materials science texts sold annually in the U.S. and Canada. In addition, advanced high school chemistry or physics courses often include a significant polymer materials component. The National Science Teachers Association has a high school supplement text which is very popular with high school teachers throughout the country. Although many of these texts come with instructions for experiments and demonstrations, in reality these are rarely done because of the difficulty in obtaining the materials in a timely and inexpensive fashion.

Polymeric materials are unique because of their polymeric nature. Large molecular weight molecules behave, in general, very differently from low molecular weight molecules and conventional molecular or atomic solids. Many of the rules of thumb learned in elementary physics and chemistry appear to not apply in the case of polymeric materials.

Most students come into polymer courses with various concepts and preconceptions which lead them to conclude that the behavior and properties of polymers are counter intuitive. It is therefore important that they fully discover and observe the properties and behavior of polymeric materials for themselves.

I propose to develop a set of hands on discovery based experiments which students can perform for themselves.

(1)

UNIVERSITY TEACHING GRANTS — Lableless Lab

APPLICATION

NAME: J.D. Andrade RANK: Professor

DEPARTMENT: Materials Science DEPT. CHAIR: R.H. Boyd

CAMPUS ADDRESS: 2480 MEB CAMPUS PHONE: 1-4379

When would the grant activities be undertaken? F-1992, W-S-1993

SUMMARY OF PROJECT (not more than 150 words):

A very large number of science and engineering courses taught in colleges and universities today do not involve laboratories. Although good instructors incorporate class demonstrations, hands-on homework, and various teaching aids, including computer simulations, the fact is that students in such courses often accept key concepts and experimental results without discovering them for themselves. The only partial solution to this problem has been increasing use of class demonstrations and computer simulations.

I propose the development of a completely self-contained polymer lab which, although packaged like a textbook, will contain within it all of the materials, equipment, and information needed to directly discover and experience key concepts related to polymer materials. I expect that such a Labless Lab Book™ will be used as a supplement to the more conventional polymer science and engineering textbooks, particularly in those course which do not have a laboratory section or component.

I expect to eventually expand this approach to other science and engineering courses. It is appropriate to begin with polymer materials, however, because polymeric materials are so readily available for a wide variety of applications and because they exhibit a range of phenomena which are very easy to observe, experience, and discover.

(A)

DATE: 10/7/92 SIGNATURE: [signature]

SEND TO: University Teaching Committee
120 - E Park Building
CAMPUS