

# RHEOLOGY BULLETIN

Publication of The Society of Rheology, Inc.

Vol. 43, No. 2



August, 1974

## 45th ANNUAL MEETING

OCTOBER 21-24, 1974

University of Massachusetts  
Amherst, Massachusetts 01002

### Program

COMMITTEE: S. S. Sternstein (Chairman), J. L. Erickson, A. N. Gent, R. S. Stein, K. Wissbrun

Abstracts of the papers appear as an insert with this bulletin. The following invited lectures will be given:

1. Turner Alfrey, Mechanics of Thin Membranes as Applied to Film- and Sheet-Forming Operations
2. Howard Brenner, Suspension Rheology
3. Ian Barrie, Injection Molding, A Modern Art and a Science
4. Shigeharu Onogi, Rheo-optical Studies of Drawn Polyethylene Film
5. Roger Tanner, The Viscometry of Simple Fluids in Slow Motion
6. R. Byron Bird, Bingham Award Plenary Lecture
7. Daniel Joseph, Boundary Value Problems of Interest in Polymer Processing Using Finite Element Analysis
8. Wm. W. Graessley, Molecular Rheology of Polymers

### Local Arrangements

COMMITTEE: R. S. Porter (Chairman), R. S. Stein

The meeting lasts from Monday through Thursday noon, with buffet supper and bar available Sunday.

Accommodation forms and preregistration forms are enclosed. Additional forms can be obtained from Dr. Porter at the Polymer Science and Engineering Program at the University.

There will be two beer sessions on Monday night covering the topics, Mixing of Elastomers and The Emphasis and Relevance of Continuum Mechanics in Polymer Science Engineering Education and Practice. Contact Nobu Nakajima at the B. F. Goodrich Chemical Company, Box 122, Avon Lake, Ohio 44012 for the elastomers session and Program Chairman Sternstein for the continuum mechanics session.

### Registration and Meals

The registration desk in the Murray D. Lincoln Campus Center will be open on Sunday, October 20 from 8:00 to 10:00 p.m. and Monday from 8:00 to 10:00 a.m. Fee is \$40.00. Contact the Polymer Research Institute (413) 545-0433.

A Sunday buffet will be served from 7:00 to 10:00 p.m. in the Lincoln Campus Center. A Tuesday evening banquet will be followed by a lecture by Lawrence Nielsen on Glaciers, Gold and Iceworms. Registration fee plus banquet is \$50.00.

### Reservations

Use the reservation form enclosed with this bulletin

or contact University Conference Services, 920 Campus Center, phone: (413) 545-2591. Registration and accommodations cost \$130.00 double or \$150.00 single occupancy. Subtract \$40.00 for spouse.

### Short Course

A short course entitled "Rheo-optical Studies of Morphology, Deformation and Relaxation of Polymers" will be offered on October 19-20 prior to the annual meeting, conducted by R. S. Stein and G. L. Wilkes.

## BINGHAM MEDAL

R. Byron Bird of the Chemical Engineering Department, University of Wisconsin, is the 1974 Bingham Medalist. His biography appears on page 2.

## 46th ANNUAL MEETING

St. Louis, Missouri

OCTOBER 27-30, 1975

1. The 1975 Fall Meeting will be held at the Chase Park Plaza, St. Louis, Mo., from October 27-30. J. L. Kardos and C. T. Hill will act as Co-Chairmen of the Local Arrangements Committee. Their address is:

Materials Research Laboratory  
Washington University  
St. Louis, Missouri 63130

2. R. S. Rivlin, representing the Society of Rheology, has been elected a member of the Committee of Scientific Society Presidents. The Committee consists of the presidents of thirty-two of the major scientific societies in the United States. Its object is to facilitate the development of common points of view on the most important problems in the area of science that face the scientific community and the country.

## JOINT MEETING OF THE U. S. - JAPAN SOCIETY OF RHEOLOGY

The Princess Kaiulani Hotel, Honolulu, Hawaii

JUNE 3-6, 1975

A joint meeting of the U. S. and Japan Societies of Rheology will be held at The Princess Kaiulani Hotel, Honolulu, Hawaii, from June 3 to June 6, 1975.

Submit abstracts not more than one page and preferably without equations, by January 15, 1975 to:

R. B. Bird  
Department of Chemical Engineering  
University of Wisconsin  
Madison, Wisconsin 53706

Individual based excursion tour fare is planned. Special ITX fares are available. Contact R. E. Coulehoun, 13 Allen St., Dobbs Ferry, New York 10522.

## RHEOLOGY BULLETIN

Raymond R. Myers, Editor

Department of Chemistry

Kent State University

Kent, Ohio 44242

### RHEOLOGY NOMENCLATURE

The nomenclature committee (C. Sieglauff, Chairman, R. Bird, R. Dickie, F. Eirich, H. Markovitz, R. Myers) has circulated to the Executive Committee of the Society of Rheology the attached nomenclature list. The Executive Committee has accepted this list for use by the Society. It is recommended that the members of the Society adhere to this nomenclature for their communications to the Society.

Reference should be made to earlier communications by H. Leaderman and by a committee established by the Society and chaired by R. R. Myers. These recommendations were published in the *Transactions* 1, 213 (1957) and 3, 205 (1959).

These recommendations will be published in the *Transactions* after a reasonable time for communications by the membership to Dr. Sieglauff, Diamond Shamrock Co., Painesville, Ohio.

### BIOGRAPHICAL SKETCH OF PROFESSOR R. B. BIRD

Professor R. Byron Bird, the Bingham Medalist for 1974, is Vilas Research Professor of Chemical Engineering at the University of Wisconsin. His career is distinguished not only by significant research in rheology, but also by his outstanding accomplishments as an educator. The book *Transport Phenomena*, which he co-authored in 1960 with W. E. Stewart and E. N. Lightfoot, is available in four languages and is a standard chemical engineering text. He is also coauthor with J. O. Hirschfelder and C. F. Curtis of the well known treatise *Molecular Theory of Gases and Liquids*. Professor Bird's interest in foreign languages is evidenced by coauthorship of books for study of Dutch and of Japanese.

Professor Bird received a bachelor's degree in Chemical Engineering from the University of Illinois in 1947 and a Ph.D. in Chemistry from the University of Wisconsin in 1950. He holds honorary degrees (D. Eng.) from Lehigh University and Washington University. Following a year on the faculty at Cornell University, he joined the Department of Chemical Engineering at the University of Wisconsin in 1953, where he served as Chairman for four years beginning in 1964.

Professor Bird has a world-wide reputation for his ability as a lucid lecturer. He has been a Fulbright Lecturer on several occasions and was a Guggenheim Fellow in Delft during 1958.

The Medalist's research in rheology has resulted in fundamental contributions in a variety of areas, but he is probably best known for his work on development and testing of constitutive models. Most of his recent work in this area has been concerned with various kinds of dumbbell models as prototypes for dilute polymer solutions.

## SEVENTH INTERNATIONAL CONGRESS OF RHEOLOGY

Chalmers University of Technology

Gothenburg, Sweden

AUGUST 23-27, 1976

The Seventh International Congress on Rheology will be held at Chalmers University of Technology, Gothenburg, Sweden, August 27-27, 1976.

The Congress will be organized by the Swedish Rheological Society, a special section of the Swedish National Committee on Mechanics. It will be held under the auspices of the International Committee on Rheology with Robert S. Marvin as Honorary President.

The first circular concerning the Congress will be issued in autumn, 1974.

Organizing Committee:

Josef Kubat, Chairman

Chalmers University of Technology

Fack

S-402 20 Gothenburg

Sweden

E. Forslind

L-E Gelin

F.K.G. Odqvist

### REPORT OF THE EDITOR

MAY 2, 1974

#### *Publication Trends*

Volume 17 contained 669 pages comprising 38 papers and 4 notes. Contributions in the form of notes are becoming more frequent as attested to by the fact that they comprise, numerically, 10% of the offerings in Volume 17.

My October 26, 1973 report erroneously listed too many pages for Volume 17, the figure having been derived from Wiley's estimate. Issue 4 contained only five papers and two notes, in contrast to an expectation of double that figure. The corrected table appears here:

TABLE 1. Size of TSOR

| Volume         | Year | Papers | Pages |
|----------------|------|--------|-------|
| 14             | 1970 | 38     | 622   |
| 15             | 1971 | 44     | 791   |
| 16             | 1972 | 46     | 776   |
| 17             | 1973 | 38     | 669   |
| 18 (projected) |      |        | 600   |

Our instructions to Wiley Interscience call for a 600-page Volume 18. Manuscripts are arriving at a steady rate and are being accepted at a rate which will permit us to maintain that level of publication. Whether we can begin to invoke the two-track system authorized by the executive committee several years ago remains to be seen; but the first three issues of Volume 18 will go to press without any differentiation between paid and unpaid manuscripts.

#### *TSOR Manuscripts*

Volume 18 Issue 1 already contains nine papers totaling 190 pages, reflecting a slight backlash from Volume 17 Issue 4. In addition, 19 manuscripts have been accepted and are in Wiley-Interscience's hands.

We rejected 20 papers last year.

The assistant editors are in possession of a total of 46 submitted manuscripts, proportioned among the extremely helpful assistant editors:

William W. Graessley

J. George Savins

Mitchel C. Shen

James L. White

Edward B. Bagley

Raymond R. Myers

## MINUTES OF EXECUTIVE COMMITTEE MEETING

MAY 2, 1974

AIP Offices, 335 East 45th St., New York City

Executive Committee members present: E. Collins, F. Eirich, J. Knox, I. Krieger, R. Myers, R. Rivlin, and L. Zapas. Others present: R. Coulehan, R. Marvin, S. Sternstein, M. Nightingale (AIP). The meeting was called to order at 1:10 p.m.

1. In the absence of the Secretary, J. R. Knox was appointed Sect. pro tem.
2. Minutes of the previous meeting (October 28, 1973) were approved as presented.
3. R. S. Rivlin reported on committee membership appointments:
  - a. Executive Committee: (elective, reported in April issue of Bulletin).
  - b. Local Arrangements 1974 Annual Meeting: R. S. Porter (ch.), R. A. Mendelson, S. Middleman, R. S. Stein.
  - c. Program 1974 Annual Meeting: S. S. Sternstein (ch.), J. L. Ericksen, A. N. Gent, R. S. Stein, K. F. Wissbrun.
  - d. Local Arrangements 1975 Hawaii Meeting: N. W. Tschoegl (ch.), H. Kambe (Japan Society), J. A. Mann (U. of Hawaii).
  - e. Program 1975 Hawaii Meeting: R. B. Bird (ch.), D. C. Bogue, R. S. Marvin, Y. Mori (Japan Society), S. Onogi (Japan Society), K. Umeya (Japan Society).
  - f. Bingham Award Committee: W. R. Schowalter (ch.), (1974), E. Baer (1975), R. L. Ballman (1976), D. H. Kaelble (1975), E. H. Lee (1976), B. D. Marsh (1974).
  - g. Nominating: F. R. Eirich (ch.)
  - h. Nomenclature: C. Sieglaff (ch.), R. B. Bird, R. Dickie, F. R. Eirich, R. R. Myers, N. W. Tschoegl.
  - i. Site Selection and Topics: E. A. Collins (ch.), R. P. Chartoff, R. S. Marvin, R. R. Myers, M. C. Shen.
  - j. Membership: G. E. Fulmer (ch.).
  - k. Industrial-University Relations: J. T. Bergen (ch.).
  - l. Representative on National Committee on Theoretical and Applied Mechanics: R. S. Rivlin.
  - m. Delegate to International Committee on Rheology: R. S. Marvin.
  - n. Short Courses: M. H. Birnboim, W. W. Graessley.

Some discussion followed on the relative advisability of ad hoc vs. set tenure standing committees.

4. R. R. Myers presented the Editor's Report, which is attached in total. He reported that Volume 17 contained 669 pages comprising 38 papers and 4 notes. Volume 18 is projected to contain 600 pages. Issue 1 already contains 9 papers totaling 190 pages.
5. A discussion was conducted with R. Marks and H. W. Koch of AIP in attendance concerning the AIP Long Range Planning Committee recommendation that member societies should conduct a minimum of 50% of their business through AIP. This would entail AIP publishing the Transactions for the Society. It was pointed out that past evaluations had indicated that AIP costs would be higher than current Wiley/Interscience charges to the Society and that AIP had not in the past shown significant interest in publishing the Transactions. It was further expres-

sed that the concern of the Executive Committee was, and the concern of AIP should be, to provide the best journal service at the lowest net cost to the Society. In response to the AIP Long Range Planning Committee recommendation and to the discussions with Marks and Koch, a motion was passed to request AIP to make an estimate of publication costs to publish the Transactions of the Society of Rheology under each of two sets of conditions: (a) no risk-no profit to the Society, and (b) return of profit or loss to the Society. It was agreed that no action could be taken by the Society in response to AIP proposals prior to June 1975 contract renewal discussions.

6. R. S. Marvin reported that the International Committee on Rheology had accepted the invitation to hold the Seventh International Congress on Rheology at Gothenburg, Sweden, at Chalmers University of Technology in the middle to last part of August, 1976. He also reported that the Society has formally been accepted as an affiliate of IUPAC. R. S. Rivlin will appoint an additional delegate to Intern. Comm. on Rheology.
7. E. A. Collins presented the Treasurer's report including the attached Statement of Receipts and Disbursements, Year End Dec. 31, 1973; Summary Sheet - Annual Meetings; Summary Sheet of Year-End Financial Condition 1965-73; and a break-down of current interest and return from short courses. The report was approved as presented.
8. R. S. Rivlin presented a status report on local arrangements for the 1974 Annual Meeting for R. S. Porter, and S. S. Sternstein covered program plans. In addition to the meeting a short course on Rheo-optics will be held.
9. R. S. Rivlin reported on the status of plans for a joint meeting with the Japan Society of Rheology in Hawaii, June 3-6, 1975.
10. E. A. Collins reported on Site Selection Committee activities. There will be no 1975 Winter Meeting. Tentative plans have been reported for the June 1975 Hawaii meeting. The 46th Annual Meeting is scheduled for Oct. 26-30, 1975 at the Chase Park Plaza Hotel in St. Louis. Tentative plans are being made as follows: A January 1976 Winter Meeting at the Jack Tar Hotel, San Francisco, the International Congress to take the place of a Fall meeting in 1976, and the 1976 "Annual" Meeting to be held in the winter of 1977 in New York and the 1977 Annual Meeting to be held in the Fall at Atwood Lodge, OH.
11. E. A. Collins has revised the Manual for Chairman of the Program Committee, and copies were distributed at the meeting.
12. Following discussion of the roles of the Membership and Industrial-University Relations Committees, the meeting was adjourned at 5:35 p.m.  
Respectfully submitted,  
R. A. Mendelson, Secretary

## WINTER GORDON CONFERENCE ON POLYMERS

JANUARY 19-24, 1975

The Gordon Research Conferences on Polymers will be held at the Miramar Hotel in Santa Barbara, California January 19-24, 1975. Write to Charles Sieglaff, Diamond Shamrock Co., Painesville, Ohio 44060.

**AMERICAN INSTITUTE OF PHYSICS INCORPORATED  
FOR SOCIETY OF RHEOLOGY**

Statement of Receipts and Disbursements — Year Ended December 31, 1973

|                                                               |                 |                    |
|---------------------------------------------------------------|-----------------|--------------------|
| Balance in Account - January 1, 1973                          |                 | \$22,578.57        |
| <b>RECEIPTS (January 1 - December 31, 1973)</b>               |                 |                    |
| Dues Collections:                                             |                 |                    |
| 1973                                                          | \$3,820.12      |                    |
| 1974 Dues                                                     | <u>5,570.00</u> | 9,390.12           |
| Miscellaneous Income:                                         |                 |                    |
| Income from Winter Meeting                                    | \$ 263.15       |                    |
| Interest Income                                               | <u>60.00</u>    | 323.15             |
| Total Receipts                                                |                 | <u>\$32,291.84</u> |
| <b>DISBURSEMENTS (January 1 - December 31, 1973)</b>          |                 |                    |
| Charge for Dues Billing and Collection                        | \$ 618.98       |                    |
| Charge for Preparation and Maintenance of Member Record File  | 1,182.76        |                    |
| Financial Handling Charge - Year - 1973                       | 261.32          |                    |
| Member Society Dues - Year - 1973                             | 792.00          |                    |
| Editorial Expenses:                                           |                 |                    |
| Secretary, Telephone and Postage                              | 1,300.00        |                    |
| Transactions of the Society of Rheology (Schedule A)          | 1,974.78        |                    |
| S of R Transactions:                                          |                 |                    |
| Mailing Expense                                               | \$ 711.81       |                    |
| Subscription Expense                                          | <u>1,879.02</u> | 2,590.83           |
| Winter Meeting:                                               | 484.01          |                    |
| Spring Bulletin:                                              | 331.82          |                    |
| Fall Bulletin:                                                | 135.86          |                    |
| Mailing Ballot:                                               | 94.84           |                    |
| Questionnaire:                                                | 84.75           |                    |
| Addressing Lists                                              | 43.09           |                    |
| Abstracts for 44th Annual Meeting:                            | 597.05          |                    |
| Mailing Abstracts and Newsletter:                             | 344.54          |                    |
| Brochure:                                                     | 87.78           |                    |
| Mailing Bulletin, Registration Form, and Brochure:            | 112.33          |                    |
| S of R Letterhead:                                            | 55.06           |                    |
| Advance to Chairman for Montreal Conference 10-28-73          | 700.00          |                    |
| Retirement Gifts for E. Wolf                                  | 400.00          |                    |
| Other                                                         | 181.62          |                    |
| Total Disbursements                                           |                 | <u>12,373.42</u>   |
|                                                               |                 | \$19,918.42        |
| <b>LESS: Transfer of Funds to Society of Rheology 8-13-73</b> |                 | 12,000.00          |
| Balance in Account - December 31, 1973                        |                 | <u>\$ 7,918.42</u> |
| Savings and Loan Bonds                                        |                 | 10,000.00          |
| Savings Account                                               |                 | 3,106.40           |
| <b>Balance</b>                                                |                 | <u>\$21,024.82</u> |

SUMMARY SHEET TREASURER'S REPORT

|                   | Balance<br><u>In Account</u> | Transactions<br><u>Income or (Expense)</u> |
|-------------------|------------------------------|--------------------------------------------|
| December 31, 1965 | \$ 8,127.42                  |                                            |
| December 31, 1966 | \$14,264.04                  |                                            |
| December 31, 1967 | \$13,259.02                  | (\$6,029.92)                               |
| December 31, 1968 | \$20,943.60                  | \$ 669.21                                  |
| December 31, 1969 | \$15,942.00                  | (\$6,746.57)                               |
| December 31, 1970 | \$16,105.83                  | (\$2,666.31)                               |
| December 31, 1971 | \$17,175.56                  | (\$1,198.53)                               |
| December 31, 1972 | \$22,578.57                  | (\$4,825.67)                               |
| December 31, 1973 | \$21,024.82                  | (\$1,974.78)                               |

(Continued on Page 5)

(Continued from Page 4)

**TREASURER'S REPORT**

MAY 2, 1974

(Interest and Short Courses)

|                                       |          |
|---------------------------------------|----------|
| Interest from bonds to date .....     | \$337.55 |
| Interest from savings account .....   | 10.41    |
| Net Income from First Short Course —  |          |
| 1971 Knoxville .....                  | 737.05   |
| Net Income from Second Short Course — |          |
| 1973 Montreal .....                   | 922.70   |

**FINANCIAL STATEMENT  
SHORT COURSE - MONTREAL**

OCTOBER 1973

|                                   |            |               |
|-----------------------------------|------------|---------------|
| Income (total attendance - 32)    |            | \$2,000.00    |
| Expenses                          |            |               |
| Miscellaneous (E. A. Collins)     | \$ 33.54   |               |
| Prof. W. Graessley (Lecturer)     | 658.76     |               |
| Prof. Kamal (facility)            | 225.00     |               |
| Rensselaer Polytechnic (printing) | 160.00     |               |
|                                   | \$1,077.30 | \$1,077.30    |
| Income                            |            | \$ 922.70     |
|                                   |            | E. A. Collins |

**TRANSACTIONS OF THE SOCIETY OF RHEOLOGY — SCHEDULE A**

Statement of Income and Expense — Year Ended December 31, 1973

**INCOME**

|                                                            |            |
|------------------------------------------------------------|------------|
| Publication Charges (Vol. 16 No. 4; Vol. 17 No. 1 - No. 4) | \$4,815.00 |
| Reprint Sales (Vol. 16 No. 4; Vol. 17 No. 1 - No. 4)       | 2,368.46   |
| Total Income                                               | \$7,183.46 |

**EXPENSES**

|                               |                     |
|-------------------------------|---------------------|
| Publishing Expense (Vol. 16)  | \$6,490.11          |
| Printing Reprints (Wiley)     | 2,218.61            |
| Printing Mailing Labels       | 12.14               |
| Reprint Order Handling Charge | 437.38              |
| Total Expense                 | 9,158.24            |
| Net Income or (Expense)       | <u>(\$1,974.78)</u> |

Respectfully Submitted,  
E. A. Collins, Treasurer

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**Application for Membership in the  
SOCIETY OF RHEOLOGY**

I hereby desire to apply for membership in the SOCIETY OF RHEOLOGY dating from  
January 19.....

Name .....  
(Include Title, e.g., Mr., Dr., Prof., Miss, etc.) Please print.

Mail Address .....

Mail Address .....

Professional Connection .....

Position .....

Chief Interest .....

Highest Academic Degree .....

Date .....

Enclose Remittance of \$10 for Regular Annual Dues or \$100 for Sustaining Annual Dues  
and Mail to:

SOCIETY OF RHEOLOGY  
American Institute of Physics  
335 East 45 Street  
New York, New York 10017

## NOMENCLATURE COMMITTEE RECOMMENDATIONS

### Nomenclature for Simple Steady Shear Flow

$$[v_x = f(v_y) \text{ or } v_1 = f(x_2)]$$

| <u>Symbol</u>               | <u>Name</u>                               | <u>Definition</u>                                           | <u>Units</u>                                         |
|-----------------------------|-------------------------------------------|-------------------------------------------------------------|------------------------------------------------------|
| X,1                         | Geometric Direction of flow               | -                                                           | -                                                    |
| Y,2                         | Direction of velocity change              | -                                                           | -                                                    |
| Z,3                         | Neutral Direction                         | -                                                           | -                                                    |
| $\sigma \equiv \sigma_{21}$ | Shear stress in simple steady shear flow  | -                                                           | dynes $\text{cm}^{-2}$<br>(newtons $\text{m}^{-2}$ ) |
| $\dot{\gamma}$              | Shear rate                                | $dv_x/dy$                                                   | $\text{sec}^{-1}$                                    |
| $\eta$                      | Viscosity                                 | $\sigma/\dot{\gamma}$                                       | poise<br>(dyne sec $\text{cm}^{-2}$ )                |
| $N_1$                       | First normal stress function              | $\sigma_{11} - \sigma_{22}$                                 | dynes $\text{cm}^{-2}$<br>(newton $\text{m}^{-2}$ )  |
| $N_2$                       | Second normal stress function             | $\sigma_{22} - \sigma_{33}$                                 | dynes $\text{cm}^{-2}$<br>(newton $\text{m}^{-2}$ )  |
| $\Psi_1$                    | First normal stress coefficient           | $N_1/\dot{\gamma}^2$                                        | dynes $\text{sec}^2 \text{cm}^{-2}$                  |
| $\Psi_2$                    | Second normal stress coefficient          | $N_2/\dot{\gamma}^2$                                        | dynes $\text{sec}^2 \text{cm}^{-2}$                  |
| $\eta_0$                    | Limiting viscosity at zero shear rate     | $L (\sigma/\dot{\gamma})$                                   | poise<br>(dyne sec $\text{cm}^{-2}$ )                |
| $\eta_\infty$               | Limiting viscosity at infinite shear rate | $L (\sigma/\dot{\gamma})_{\dot{\gamma} \rightarrow \infty}$ | poise<br>(dyne sec $\text{cm}^{-2}$ )                |
| $\eta_s$                    | Viscosity of solvent or continuous medium | -                                                           | poise<br>(dyne sec $\text{cm}^{-2}$ )                |
| $\eta_r$                    | Relative viscosity                        | $\eta/\eta_s$                                               | dimensionless                                        |
| $\eta_{sp}$                 | Specific viscosity                        | $\eta_r - 1$                                                | dimensionless                                        |
| $[\eta]$                    | Intrinsic viscosity                       | $L \frac{\eta_r - 1}{C}$<br>$C \rightarrow 0$               | $\text{cm}^{-3}$ or units<br>of C                    |

# Nomenclature for Small Amplitude Oscillatory Motion

| <u>Symbol</u> | <u>Name</u>                         | <u>Units</u>                    |
|---------------|-------------------------------------|---------------------------------|
| $\omega$      | Angular frequency                   | $\text{sec}^{-1}$               |
| $t$           | Time                                | sec                             |
| $\tau$        | Relaxation time or retardation time | sec                             |
| $\eta^*$      | Complex dynamic shear viscosity     | dyne sec $\text{cm}^{-2}$       |
| $\eta'$       | Dynamic viscosity                   |                                 |
| $\eta''$      | Out-of-phase component of $\eta^*$  |                                 |
| $B^*$         | Bulk dynamic complex compliance     | dyne $\text{cm}^{-2}$           |
| $B'$          | Bulk storage compliance             |                                 |
| $B''$         | Bulk loss compliance                |                                 |
| $B(t)$        | Bulk creep compliance               |                                 |
| $D^*$         | Tensile dynamic complex compliance  | dyne $\text{cm}^{-2}$           |
| $D'$          | Tensile storage compliance          |                                 |
| $D''$         | Tensile loss compliance             |                                 |
| $D(t)$        | Tensile creep compliance            |                                 |
| $E^*$         | Tensile dynamic complex modulus     | dyne $\text{cm}^{-2}$           |
| $E'$          | Tensile storage modulus             |                                 |
| $E''$         | Tensile loss modulus                |                                 |
| $E(t)$        | Tensile relaxation modulus          |                                 |
| $G^*$         | Complex dynamic shear modulus       | dyne $\text{cm}^{-2}$           |
| $G'$          | Shear storage modulus               |                                 |
| $G''$         | Shear loss modulus                  |                                 |
| $G(t)$        | Shear relaxation modulus            |                                 |
| $J^*$         | Complex dynamic shear compliance    | $\text{cm}^2 \text{ dyne}^{-1}$ |
| $J'$          | Shear storage compliance            |                                 |
| $J''$         | Shear loss compliance               |                                 |
| $J(t)$        | Shear creep compliance              |                                 |

## Nomenclature for Small Amplitude Oscillatory Motion

| <u>Symbol</u> | <u>Name</u>                     | <u>Units</u>          |
|---------------|---------------------------------|-----------------------|
| K*            | Bulk dynamic complex modulus    | dyne cm <sup>-2</sup> |
| K'            | Bulk storage modulus            |                       |
| K''           | Bulk loss modulus               |                       |
| K(t)          | Bulk relaxation modulus         |                       |
| μ*            | Complex dynamic Poisson's ratio | dimensionless         |
| μ'            | In-phase component of μ*        |                       |
| μ''           | Out-of-phase component of μ*    |                       |

## Nomenclature for Small Deformation Linear Elasticity

| <u>Symbol</u>                       | <u>Name</u>                         | <u>Units</u>                        |
|-------------------------------------|-------------------------------------|-------------------------------------|
| <u>Simple Shear</u>                 |                                     |                                     |
| G                                   | Shear modulus - modulus of rigidity | dynes cm <sup>-2</sup>              |
| J                                   | Shear compliance                    | cm <sup>2</sup> dynes <sup>-1</sup> |
| <u>Bulk (Isotropic) Compression</u> |                                     |                                     |
| K                                   | Bulk modulus                        | dynes cm <sup>-2</sup>              |
| B                                   | Bulk compliance                     | cm <sup>2</sup> dynes <sup>-1</sup> |
| <u>Tensile Extension</u>            |                                     |                                     |
| E                                   | Young's modulus (tensile modulus)   | dynes cm <sup>-2</sup>              |
| D                                   | Tensile compliance                  | cm <sup>2</sup> dynes <sup>-1</sup> |
| μ                                   | Poisson's ratio                     | dimensionless                       |