

Official Nomenclature of US and European Societies of Rheology (2018-10)

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TABLE I. Steady simple shear (viscometric flow)

Name	Definition	Symbol	SI units ^a
Direction of flow (simple shear)		x_1	m
Direction of velocity gradient (simple shear)		x_2	m
Neutral direction (simple shear)		x_3	m
Shear or normal force	ma	F	N
Velocity	dx_1/dt	v_1	m s^{-1}
Acceleration	dv_1/dt	a_1	m s^{-2}
Shear stress ^b	F/A	σ	Pa
Shear strain	dx_1/dx_2	γ	–
Shear rate	$ dv_1/dx_2 $	$\dot{\gamma}$	s^{-1}
Vorticity ^c	$-dv_1/dx_2$	ω_3	s^{-1}
Viscosity	$ \sigma /\dot{\gamma}$	$\eta(\dot{\gamma})$	Pa s
Yield stress		σ_y	Pa
Yield strain		γ_y	–
First normal stress difference	$\sigma_{11} - \sigma_{22}$	N_1	Pa
Second normal stress difference	$\sigma_{22} - \sigma_{33}$	N_2	Pa
First normal stress coefficient	$N_1/\dot{\gamma}^2$	Ψ_1	Pa s^2
Second normal stress coefficient	$N_2/\dot{\gamma}^2$	Ψ_2	Pa s^2
Normal stress ratio	$-N_1/N_2$	$\Psi(\dot{\gamma})$	–
Zero-shear viscosity (limiting low shear rate viscosity)	$\eta(\dot{\gamma} \rightarrow 0)$	η_0	Pa s
Zero-shear first normal stress coefficient	$\Psi_1(\dot{\gamma} \rightarrow 0)$	$\Psi_{1,0}$	Pa s^2
Consistency index in power law for viscosity	$\eta = K\dot{\gamma}^{n-1}$	n	–
Constant in power law for viscosity	see above equation	K	Pa s^n

^a SI allows either a dot between units or a space, as used here.

^b A is the area in m^2 .

^c In the fluid dynamics community a prefactor of 1/2 is used in the definition of the vorticity.

TABLE II. Linear viscoelasticity

Name	Definition	Symbol	Units
<i>Simple shear</i>			
Shear modulus of a solid	σ/γ	G	Pa
Relaxation modulus	$\sigma(t)/\gamma$	$G(t)$	Pa
Relaxation strength in discrete spectrum	–	g_i	Pa
Relaxation time in discrete spectrum	–	τ_i	s
Continuous relaxation spectrum	– ^a	$H(\tau)$	Pa
Orthogonal superposition complex modulus ^{b,c}	–	$G_{\perp}^*(\omega, \dot{\gamma})$	Pa
Parallel superposition complex modulus ^{b,c}	–	$G_{\parallel}^*(\omega, \dot{\gamma})$	Pa
Memory function	$-dG(s)/ds$	$m(s)$	Pa s ⁻¹
Creep compliance (shear)	$\gamma(t)/\sigma$	$J(t)$	Pa ⁻¹
Equilibrium compliance of solid	$J(t) (t \rightarrow \infty)$	J_e	Pa ⁻¹
Recoverable compliance	$J(t) - t/\eta_0$	$J_r(t)$	Pa ⁻¹
Steady-state compliance of fluid	$J(t) - t/\eta_0 (t \rightarrow \infty)$	J_s^0	Pa ⁻¹
Continuous retardation spectrum ^d	– ^d	$L(\tau)$	Pa ⁻¹
<i>Small-amplitude oscillatory shear</i>			
Strain amplitude	$\gamma(t) = \gamma_0 \sin \omega t$	γ_0	–
Loss angle (phase angle)	$\sigma(t) = \sigma_0 \sin(\omega t + \delta)$	δ	rad
Stress amplitude	$\sigma(t) = \sigma_0 \sin(\omega t + \delta)$	σ_0	Pa
Complex modulus	$G' + iG''$	G^*	Pa
Absolute magnitude of G^*	σ_0/γ_0	$ G^* $ or G_d	Pa
Storage modulus	$G_d \cos \delta$	G'	Pa
Loss modulus	$G_d \sin \delta$	G''	Pa
Complex viscosity	$\eta' - i\eta''$	η^*	Pa s
Absolute magnitude of η^*	$\sigma_0/\omega\gamma_0$	$ \eta^* $	Pa s
Dynamic viscosity (in phase with strain rate)	G''/ω	η'	Pa s
Out-of-phase (with strain rate) component of η^*	G'/ω	η''	Pa s
Complex compliance	$J' - iJ''$	J^*	Pa ⁻¹
Absolute magnitude of J^*	$\gamma_0/\sigma_0 = 1/G_d$	$ J^* $	Pa ⁻¹
Storage compliance	$(\gamma_0/\sigma_0) \cos \delta$	J'	Pa ⁻¹
Loss compliance	$(\gamma_0/\sigma_0) \sin \delta$	J''	Pa ⁻¹
Plateau modulus ^e	– ^e	G_N^0	Pa
<i>Tensile (Uniaxial) Extension^c</i>			
Net tensile stress	$\sigma_{zz} - \sigma_{rr}$	σ_E	Pa
Hencky strain	$\ln(L/L_0)$	ε	–
Hencky strain rate	$d(\ln L)/dt$	$\dot{\varepsilon}$	s ⁻¹
Tensile relaxation modulus	$\sigma_E(t)/\varepsilon_0$	$E(t)$	Pa
Tensile creep compliance	$\varepsilon_0(t)/\sigma_E$	$D(t)$	Pa ⁻¹

^a $G(t) = \int_{-\infty}^{\infty} H(\tau)[\exp(-t/\tau)] d(\ln \tau)$

^b The same subscripts apply to definitions of storage and loss moduli and viscosities.

^c Also applies to nonlinear phenomena in uniaxial extension.

$${}^d J(t) = \int_{-\infty}^{\infty} L(\tau)[1 - \exp(t/\tau)]d(\ln\tau)$$

^e Because there is not a true plateau in $G(t)$ or $G'(\omega)$, G_N^0 is inferred from $G'(\omega)$ and $G''(\omega)$ using methods reviewed by Liu *et al.* [Polymer **47**, 4461–4479 (2006)].

TABLE III. Shift factors for time-temperature superposition

Name	Definition	Symbol	SI Units
Vertical shift factor ^a	$b_T G'(T, \omega a_T) = G'(T_0, \omega)$	b_T	–
Horizontal shift factor	$b_T G'(T, \omega a_T) = G'(T_0, \omega)$	a_T	–
First WLF coefficient	$\log_{10} a_T = \frac{-c_1(T - T_0)}{[c_2 + (T - T_0)]}$	c_1	–
Second WLF coefficient	$\log_{10} a_T = \frac{-c_1(T - T_0)}{[c_2 + (T - T_0)]}$	c_2	K
Activation energy for flow	$a_T = \exp\left[\frac{E_a}{R}\left(\frac{1}{T} - \frac{1}{T_0}\right)\right]$	E_a	kJ mol ⁻¹

^a For rubbers, b_T is given by $T_0\rho_0/T\rho$, where ρ is mass density, with $\rho_0 = \rho(T_0)$ [J. D. Ferry, Viscoelastic properties of polymers, 3rd Ed., Wiley, NY, 1980]. It has also been found to be appropriate for polymers in general.

TABLE IV. Nonlinear viscoelasticity in shear

Name	Definition	Symbol	SI Units
<i>Stress relaxation (step strain)</i>			
Strain amplitude		γ_0	–
Relaxation modulus (nonlinear)	$\sigma(t)/\gamma_0$	$G(t, \gamma_0)$	Pa
Damping function in shear	$G(t, \gamma_0)/G(t)$	$h(\gamma_0)$	–
First normal stress relaxation function		$N_1(t, \gamma_0)$	Pa
Second normal stress relaxation function		$N_2(t, \gamma_0)$	Pa
First normal stress relaxation coefficient	$N_1(t, \gamma_0)/\gamma_0^2$	$\Psi_1(t, \gamma_0)$	Pa
Second normal stress relaxation coefficient	$N_2(t, \gamma_0)/\gamma_0^2$	$\Psi_2(t, \gamma_0)$	Pa
<i>Start-up of steady shear (at fixed shear rate)</i>			
Shear stress growth function		$\sigma^+(t, \dot{\gamma})$	Pa
Shear stress growth coefficient	$\sigma^+(t, \dot{\gamma})/\dot{\gamma}$	$\eta^+(t, \dot{\gamma})$	Pa s
First normal stress growth function	$\sigma_{11} - \sigma_{22}$	$N_1^+(t, \dot{\gamma})$	Pa
First normal stress growth coefficient	$N_1^+(t, \dot{\gamma})/\dot{\gamma}^2$	$\Psi_1^+(t, \dot{\gamma})$	Pa s ²
Second normal stress growth function	$\sigma_{22} - \sigma_{33}$	$N_2^+(t, \dot{\gamma})$	Pa
Second normal stress growth coefficient	$N_2^+(t, \dot{\gamma})/\dot{\gamma}^2$	$\Psi_2^+(t, \dot{\gamma})$	Pa s ²
Stress Ratio	$N_1(\dot{\gamma})/\sigma(\dot{\gamma})$	SR	–
<i>Cessation of steady shear ($\dot{\gamma} = 0$ from $t = 0$)</i>			
Shear stress decay function		$\sigma^-(t, \dot{\gamma})$	Pa
Shear stress decay coefficient	$\sigma^-(t, \dot{\gamma})/\dot{\gamma}$	$\eta^-(t, \dot{\gamma})$	Pa s
First normal stress decay function	$\sigma_{11} - \sigma_{22}$	$N_1^-(t, \dot{\gamma})$	Pa
First normal stress decay coefficient	$N_1^-(t, \dot{\gamma})/\dot{\gamma}^2$	$\Psi_1^-(t, \dot{\gamma})$	Pa s ²
Second normal stress decay function	$\sigma_{22} - \sigma_{33}$	$N_2^-(t, \dot{\gamma})$	Pa
Second normal stress decay coefficient	$N_2^-(t, \dot{\gamma})/\dot{\gamma}^2$	$\Psi_2^-(t, \dot{\gamma})$	Pa s ²
<i>Creep and creep recovery (recoil)</i>			
Creep compliance	$\gamma(t, \sigma)/\sigma$	$J(t, \sigma)$	Pa ⁻¹
Steady-state compliance ^a	$J(t \rightarrow \infty, \sigma)$	$J_s(\sigma)$	Pa ⁻¹
Recoverable strain (after t_0 when $\sigma \rightarrow 0$)	$\gamma[t_0, \sigma] - \gamma[t, \sigma]$ $t > t_0$	$\gamma_r(t', \sigma)$ $t' = t - t_0$	–
Ultimate recoil	$\gamma_r(t' \rightarrow \infty, \sigma)$	$\gamma_\infty(\sigma)$	–
Steady-state recoverable compliance ^a	$\gamma_\infty(\sigma)/\sigma$	$J_r(\sigma)$	Pa ⁻¹

^a Although measured in different ways, the steady-state compliance and the steady-state recoverable compliance should be equal to each other according to the Boltzmann principle.

TABLE V. Nonlinear viscoelasticity in extension.

Name	Definition	Symbol	SI Units
<i>Tensile (uniaxial) extension</i>			
Engineering strain ^a	$(L - L_0)/L_0$	ε	–
Engineering stress ^a	F/A_0	σ	Pa
Young's modulus of a solid	σ/ε	E	Pa
Net tensile stress (true)	$\sigma_{zz} - \sigma_{rr}$	σ_ε	Pa
Hencky strain	$\ln(L/L_0)$	ε or ϵ	–
Hencky strain rate	$d(\ln L)/dt$	$\dot{\varepsilon}$ or $\dot{\epsilon}$	s ⁻¹
Tensile stress growth function		$\sigma_E^+(t, \dot{\varepsilon})$	Pa
Tensile stress growth coefficient	$\sigma_E^+(t, \dot{\varepsilon})/\dot{\varepsilon}$	$\eta_E^+(t, \dot{\varepsilon})$	Pa s
Extensional viscosity	$\eta_E^+(t, \dot{\varepsilon}) \ t \rightarrow \infty$	$\eta_E(\dot{\varepsilon})$	Pa s
Tensile creep compliance	$\varepsilon(t)/\sigma_E$	$D(t, \sigma_E)$	Pa ⁻¹
Recoverable strain (after t_0 where $\sigma_E \rightarrow 0$)	$\varepsilon[t_0, \sigma_E] - \varepsilon[t, \sigma_E]$ $t > t_0$	$\varepsilon_r(t', \varepsilon)$ $t' = t - t_0$	–
<i>Biaxial extension (symmetrical)</i>			
Biaxial strain	$\ln(R/R_0)$	ε_B	–
Biaxial strain rate	$d(\ln R)/dt$	$\dot{\varepsilon}_B$	s ⁻¹
Net stretching stress	$\sigma_{rr} - \sigma_{zz}$	σ_B	Pa
Biaxial stretch growth function		$\sigma_B^+(t, \dot{\varepsilon}_B)$	Pa
Biaxial stretch growth coefficient	$\sigma_B^+(t, \dot{\varepsilon}_B)/\dot{\varepsilon}_B$	$\eta_B^+(t, \dot{\varepsilon}_B)$	Pa s
Biaxial stress decay coefficient	$\sigma_B^-(t, \dot{\varepsilon}_B)/\dot{\varepsilon}_B$	$\eta_B^-(t, \dot{\varepsilon}_B)$	Pa s
Biaxial extensional viscosity	$\sigma_B^+(t \rightarrow \infty, \dot{\varepsilon}_B)/\dot{\varepsilon}_B$	$\eta_B(\dot{\varepsilon}_B)$	Pa s
Biaxial creep compliance	$\varepsilon_B(t)/\sigma_B$	$D(t, \sigma_B)$	Pa ⁻¹

^a In the mechanics literature, the same symbols are often used for both engineering and true stress and strain, but they are only equivalent in the limit of very small deformations.

TABLE VI. Rheometry

Name	Definition	Symbol	SI Units
<i>Capillary rheometers</i>			
Apparent wall shear stress ^a	$P_d R/2L$	σ_A	Pa
Apparent wall shear rate	$4Q/\pi R^3$	$\dot{\gamma}_A$	s ⁻¹
Wall shear stress	$-\sigma_{rz} (r = R)$	σ_W	Pa
Wall shear rate	$-dv_z/dr (r = R)$	$\dot{\gamma}_W$	s ⁻¹
<i>Cone-plate rheometers</i>			
Cone angle	Figure 1	β	rad
Angular rotation	Figure 1	φ	rad
Angular velocity	$d\varphi/dt$	Ω	rad s ⁻¹
Torque ^b	$2\pi R^3 \sigma_{\varphi\theta}/3$	M	N m
Normal thrust	Figure 1	F_z	N

^a P_d = driving (reservoir) pressure (exit pressure neglected)

^b Approximation valid for $\beta < 0.1$ rad.

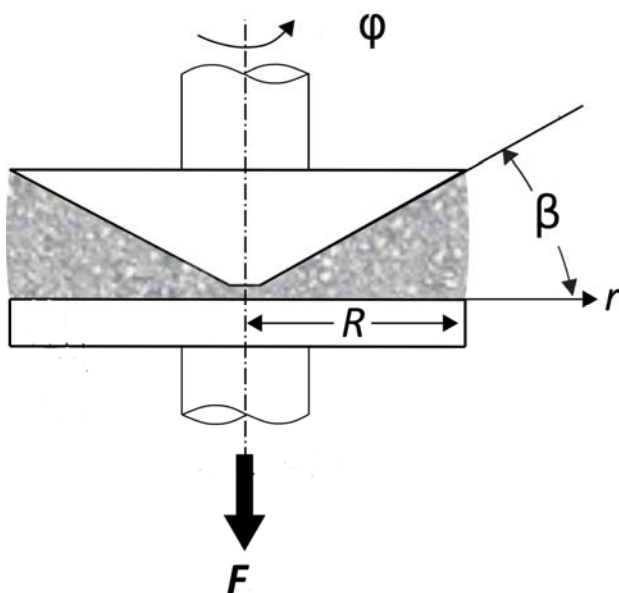


Figure 1. Symbols describing cone-plate geometry.

TABLE VII. Solutions

Name	Definition	Symbol	SI units
Concentration		c	kg m^{-3} ^a
Overlap concentration		c^*	kg m^{-3} ^a
Solvent viscosity		η_s	Pa s
Relative viscosity	(η/η_s)	η_r	–
Specific viscosity	$(\eta_r - 1)$	η_{sp}	–
Reduced viscosity	η_{sp}/c	η_{red}	$\text{m}^3 \text{kg}^{-1}$ ^b
Intrinsic viscosity	$\lim(\eta_{red}, \dot{\gamma} \rightarrow 0, c \rightarrow 0)$	$[\eta]$	$\text{m}^3 \text{kg}^{-1}$ ^b
Viscosity of matrix ^c		η_m	Pa s
Solvent contribution to the stress tensor		σ^s	Pa
Polymeric contribution to the stress tensor		σ^p	Pa

^a Units of g mL^{-1} are often used.

^b Units of mL g^{-1} are often used.

^c Often used for nanocomposites, i.e., particles in a viscoelastic matrix.

TABLE VIII. Suspensions

Name	Definition	Symbol	SI Units
Volume fraction solid	$V_{solid}/V_{suspension}$	ϕ	–
Maximum packing fraction		ϕ_{max}	–
Suspending medium viscosity ^a		η_m	Pa s
Effective viscosity of suspension	$\Sigma_{12}/\dot{\gamma}$	η	Pa s
Relative viscosity of suspension	η/η_f	η_r	–
Particle contribution to η		η_p	Pa s
Local stress tensor		$\sigma(x, t)$	Pa
Total bulk stress	$\Sigma^f + \Sigma^p$	Σ	Pa
Fluid (suspending medium) contribution		Σ^f	Pa
Particle contribution		Σ^p	Pa
First normal stress difference	$\Sigma_{11} - \Sigma_{22}$	N_1	Pa
Second normal stress difference	$\Sigma_{22} - \Sigma_{33}$	N_2	Pa
Dimensionless first normal stress difference	$-N_1/\eta_f\dot{\gamma}$	Y_1	–
Dimensionless second normal stress difference	$-N_2/\eta_f\dot{\gamma}$	Y_2	–
Particle pressure	$-\frac{1}{3}(\Sigma_{11}^p + \Sigma_{22}^p + \Sigma_{33}^p)$	Π	Pa
Hydrodynamic particle stress		Σ^H	Pa
Interparticle stress		Σ^{IP}	Pa
Brownian stress		Σ^B	Pa

^a Sometimes the subscript f is used to indicate the fluid viscosity, but it seems more adequate to use m which stands for “medium” if the suspending fluid is itself rheologically complex or “matrix” in nanocomposites. Also, μ is often used to denote fluid viscosity.

TABLE IX. Interfacial and surface rheology

Name	Definition	Symbol	SI Units
Interfacial or surface tension ^a		$\sigma_{\alpha,\beta}$	Pa m
Surface pressure	$\sigma_{\alpha,\beta}^0 - \sigma_{\alpha,\beta}(F^s/A)$	Π	Pa m
Interfacial shear stress	F^s/L	σ^s	Pa m
Interfacial shear strain	dx_1/dx_2	γ^s	–
Interfacial shear rate	dv_1/dx_2	$\dot{\gamma}^s$	s ⁻¹
Interfacial dilatational strain	$\ln(A/A_0)$	α^s	–
Interfacial dilatational strain rate	$d(\ln A)/dt$	$\dot{\alpha}^s$	s ⁻¹
Interfacial concentration	–	Γ	kg m ⁻²
<i>Steady shear and dilatation</i>			
Interfacial shear viscosity	$\sigma^s/\dot{\gamma}^s$	η^s	Pa s m
Interfacial dilatational viscosity	$\sigma^s/\dot{\alpha}^s$	κ^s	Pa s m
<i>Simple shear</i>			
Interfacial shear modulus	σ^s/γ^s	G^s	Pa m
Relaxation modulus (shear)	$\sigma^s(t)/\gamma^s$	$G^s(t)$	Pa m

<i>Pure dilatation</i>			
Interfacial dilatational modulus	σ^s/α^s	K^s	Pa m
Dilatational storage modulus	$\sigma^s(t)/\alpha^s$	$K^s(t)$	Pa m
Gibbs elasticity (surfactants) ^b	$d\sigma_{\alpha,\beta}/d(\ln A)$	K_{Π}	Pa m
<i>Small-amplitude oscillatory shear</i>			
Strain amplitude	$\gamma^s = \gamma_0^s \sin(\omega t)$	γ_0^s	–
Phase angle (loss angle)	$\sigma^s(t) = \sigma_0^s \sin(\omega t + \delta)$	δ	rad
Stress amplitude	F^s/L	σ_0^s	Pa m
Complex interfacial shear modulus	$G^{s'} + iG^{s''}$	G^{s*}	Pa m
Absolute magnitude of G^{s*}	σ_0^s/γ_0^s	$ G^{s*} $	Pa m
Storage modulus	$ G^{s*} \cos \delta$	$G^{s'}$	Pa m
Loss modulus	$ G^{s*} \sin \delta$	$G^{s''}$	Pa m
Complex shear viscosity	$\eta^{s'} - i\eta^{s''}$	η^{s*}	Pa s m
Absolute magnitude of η^{s*}	$\sigma_0^s/\omega\gamma_0^s$	$ \eta^{s*} $	Pa s m
Dynamic shear viscosity (in phase with strain rate)	$G^{s''}/\omega$	$\eta^{s'}$	Pa s m
Out-of-phase (with strain rate) component of η^{s*}	$G^{s'}/\omega$	$\eta^{s''}$	Pa s m
<i>Small-amplitude oscillatory dilatation</i>			
Dilatational strain amplitude	$\alpha^s = \alpha_0^s \sin(\omega t)$	α_0^s	–
Complex dilatational modulus ^b	$K^{s'} + iK^{s''}$	K^{s*}	Pa m
Absolute magnitude of K^{s*} ^b	σ_0^s/α_0^s	$ K^{s*} $	Pa m
Storage dilatational modulus ^b	$K^{s'}$	$K^{s'}$	Pa m
Loss dilatational modulus ^b	$K^{s''}$	$K^{s''}$	Pa m
Complex dilatational viscosity	$\kappa^{s'} + i\kappa^{s''}$	κ^{s*}	Pa s m
Absolute magnitude of κ^{s*}	$\sigma_0^s/\omega\delta_0^s$	$ \kappa^{s*} $	Pa s m
Dynamic dilatational viscosity	$K^{s''}/\omega$	$\kappa^{s'}$	Pa s m
Out-of-phase component of κ^{s*}	$K^{s'}/\omega$	$\kappa^{s''}$	Pa s m
<i>Other properties</i>			
Creep compliance (shear)	$\gamma^s(t)/\sigma^s$	$J^s(t)$	Pa ⁻¹ m ⁻¹
Equilibrium compliance of solid	$J^s(t) (t \rightarrow \infty)$	J_e^s	Pa ⁻¹ m ⁻¹
Recoverable compliance	$J^s(t) - t/\eta_0^s$	$J_r^s(t)$	Pa ⁻¹ m ⁻¹
Steady-state compliance of fluid	$J^s(t) - t/\eta_0^s (t \rightarrow \infty)$	J_0^s	Pa ⁻¹ m ⁻¹
Extensional viscosity	$\eta_E^s(t, \dot{\epsilon}^s) (t \rightarrow \infty)$	$\eta_E^s(\dot{\epsilon}^s)$	Pa s m

^a In some cases the symbols α or Γ are used to denote surface tension (not to be confused with interfacial dilatational strain or surface concentration, respectively).

^b Sometimes the symbol E is used instead of K , but this should not be confused with Young's modulus. The use of K for a compression modulus is recommended.

TABLE X. Molecular description of entangled polymers

a	tube diameter (typically in nm); average entanglement spacing / mesh size $\sqrt{\langle R^2 \rangle_0 M_e / M}$
b_K	Kuhn segment length ^a
f	tension in a chain segment (typically in N)
f_{\max}	maximum tension in a chain segment
k_B	Boltzmann's constant, $1.38 \times 10^{-23} \text{ J K}^{-1}$
L	mean tube contour length
M	molecular weight ^b , kg mol^{-1}
M_C	critical molecular weight for effect of entanglements on η_0 , kg mol^{-1}
M'_C	molecular weight for effect of entanglements on J_s^0 , kg mol^{-1}
M_e	molecular weight between entanglements ^c ($\rho RT / G_N^0$)
N_K	number of Kuhn segments in equivalent freely jointed chain ^a
p	packing length ^d ($M / [\langle R^2 \rangle_0 \rho N_A]$)
p^2	parameter to denote degree of branch point hopping within tube (fraction of tube diameter)
R	end-to-end distance of polymer molecule
R_{\max}	fully extended chain length
s	tube contour variable (curvilinear coordinate along tube)
\mathbf{S}	tube orientation tensor
Z	number of entanglement segments per molecule ^e (M / M_e)

Greek letters

α	dilution exponent for M_e
ζ	friction coefficient
ζ_0	monomer friction coefficient
λ	chain stretch; stretch ratio
ξ	correlation length; characteristic size scale (blob)
τ_d	reptation (tube disengagement) time
τ_e	Rouse time of an entanglement strand ($\tau_R / 3\pi^2 Z^2$)
τ_p	relaxation time of the p^{th} mode (p is the mode index)
τ_r	Rouse reorientation relaxation time
τ_R	Rouse stress relaxation time $[(\zeta N^2 b^2) / (6\pi^2 k_B T)]$
τ_s	stretch relaxation time ^f

^a b_K and N_K are defined by the following relationships: $\langle R^2 \rangle = b_K^2 N_K$; $R_{\max} = b_K N_K$

^b IUPAC recommends *molar mass* (MM), which has SI units of g mol^{-1} . But *molecular weight* (MW) is widely used, and ACS accepts both terms. However, MW is formally a dimensionless ratio that is numerically very close to MM (g mol^{-1}), and one cannot “change its units”. The number often called “molecular weight (kg mol^{-1})” is formally $MW/1000$ (no units). This quantity should more properly be called *molar mass* with units of kg mol^{-1} . But it is so widely called molecular weight that it seems hopeless to try to change it now.

^c This is the definition originally proposed by John Ferry. The following alternative definition was introduced much later in the context of Doi-Edwards model. It should be used in the context of the development of, or comparisons with tube-model theories: $M_e = \frac{4}{5} \rho RT / G_N^0$.

^d For a discussion of p see Fetters *et al.* [Macromolecules **27**, 4639 (1994)].

^e In tube-model theory, Z is called “number of tube segments” and is defined based on the M_e of footnote (c), i.e., using the Doi-Edwards $\frac{4}{5}$ factor. Hence, when comparing with or using tube models, the $\frac{4}{5}$ factor should be used.

^f The Rouse reorientation relaxation time was called the rotational relaxation time by Doi and Edwards and is conjectured to be equal to $2\tau_R$.

Table XI. Stress and strain tensors

Total stress tensor	σ
Extra stress tensor	τ
Strain tensor for linear viscoelasticity	γ
Cauchy tensor	\mathbf{C}
Finger tensor	\mathbf{B} or \mathbf{C}^{-1}
Doi-Edwards strain tensor	\mathbf{Q}
Rate-of-strain tensor ^a	$\dot{\gamma} = \nabla \mathbf{v} + (\nabla \mathbf{v})^T$
Vorticity tensor	$\Omega = \nabla \mathbf{v} - (\nabla \mathbf{v})^T$

^a An alternative definition, equal to $\frac{1}{2}\dot{\gamma}$, is widely used in fluid mechanics and is acceptable, but the symbol \mathbf{D} should be used for this tensor to avoid confusion: $\mathbf{D} \equiv \frac{1}{2}[\nabla \mathbf{v} + (\nabla \mathbf{v})^T]$, and in the fluid dynamics community a factor of $\frac{1}{2}$ is also used as a prefactor in the definition of the vorticity tensor Ω .

Table XII. Dimensionless groups used to describe experimental regimes

Bingham Number ^a	$Bn \equiv (\text{yield stress}) / (\text{shear stress})$
Boussinesq Number	$Bq \equiv (\text{surface shear stress}) / [(\text{bulk subphase shear stress}) \times (\text{perimeter length along which the surface shear stress acts})]$
Capillary number	$Ca = \eta v / \sigma_{\alpha,\beta} \equiv (\text{viscous forces}) / (\text{surface forces})$ or $Ca = \eta \dot{\gamma} R / \sigma_{\alpha,\beta}$
Deborah Number ^{b,c}	$De \equiv (\text{characteristic time of fluid}) / (\text{duration of deformation})$ [e.g., $De = \tau \omega$]
Péclet Number	$Pé = \dot{\gamma} a^2 / D_o \equiv (\text{rate of advection}) / (\text{rate of diffusion})$ [a = particle radius, D_o = particle diffusion coefficient]
Poisson ratio ^d	$\nu = -d\varepsilon_{\text{transverse}} / d\varepsilon_{\text{axial}} \equiv \text{negative ratio of transverse to axial strain}$
Reynolds number	$Re = \rho v d / \eta \equiv (\text{inertial forces}) / (\text{viscous forces})$ [d = characteristic length scale]
Weissenberg Number ^{b,e,f}	$Wi \equiv (\text{characteristic time of fluid}) \times (\text{rate of deformation})$ [e.g., $Wi = \tau \dot{\varepsilon}$ or $\tau \dot{\gamma}$]

^a Sometimes the wall shear stress is specifically used in the denominator of the definition, or the ratio (viscosity \times velocity)/length.

^b The definitions and uses of these groups are explained in detail in “Weissenberg and Deborah Numbers – Their definition and use”, *Rheol. Bulletin* (The Society of Rheology), **79**(2) p.14 (2010).

^c Specific Deborah numbers are often used, depending on the choice of characteristic time. Popular examples are: Deborah number based on Rouse relaxation time (De_R) and Deborah number based on longest relaxation time (De_d).

^d The Poisson ratio is also defined as function of Young's and shear modulus ($\nu = E/2G - 1$) in three dimensions (and differently in two dimensions).

^e The Weissenberg number has sometimes been considered to be N_1/σ . However, this is a ratio of dependent rather than independent variables and thus describes data rather than experimental conditions. The quantity N_1/σ is often called the *stress ratio*.

^f Specific Weissenberg numbers are often used, depending on the characteristic time. Popular examples are: Weissenberg number based on Rouse relaxation time (Wi_R) and Weissenberg number based on longest relaxation time (Wi_d).

Table XIII. Frequently used constants

N_A	Avogadro's number, 6.023×10^{23} molecules mol ⁻¹
R	Ideal gas constant, 8.314 J mol ⁻¹ K ⁻¹
k_B	Boltzmann's constant, 1.38×10^{-23} J K ⁻¹