

# Symbols

$A$	surface area of foam or foam film
$A_i$	Initial area of foam film
$A_s$	cross-sectional area of foam film
$A^f$	area of liquid film
$a$	activity of solute
$a_h$	effective head group area of surfactant
$a_c$	condensation coefficient
$B_c$	film breaking coefficient
$B, B_1, B_3, B_4$	proportionality constants
$C$	concentration
$C_s$	surfactant concentration in solution
$C_{el}$	electrolyte concentration in solution
$C_{el,cr}$	critical electrolyte concentration
$C_b$	concentration of black spot formation
$C_{NBF}$	critical surfactant concentration for Newton black film formation
$C_e$	equilibrium surfactant concentration of Newton black film stability
$C_{max}$	maximum surfactant concentration (for bubble coalescence)
$C_{PB}$	transitional electrolyte concentration (Prince and Blanch)
$D$	diffusion coefficient of surfactant molecules in bulk solution
$D_g$	diffusion coefficient of gas from a shrinking bubble
$D_f$	diffusion coefficient of gas
$D_{eff}$	effective diffusion coefficient of gas
$D_w$	diffusion coefficient of gas through aqueous core of thin film
$D_s$	surface diffusion coefficient
$D_v$	coefficient of vacancy diffusion in an amphiphile bilayer
$d$	bubble diameter
$d_{eq}$	bubble equivalent diameter
$d_v$	bubble vertical diameter
$d_h$	bubble horizontal diameter
$dx$	small change in distance caused by stretching liquid film
$E_g$	Gibbs coefficient of surface elasticity
$E_a$	activation energy
$E_c$	entry coefficient
$E_g$	generalized entry coefficient

$E^*$	complex dilational visco-elastic modulus
$E'$	real part of $E^*$ (storage modulus)
$E''$	imaginary part of $E^*$ (the loss modulus)
$F$	force
$F_b$	buoyancy force
$F_s$	force associated with surface tension
$F_c$	capillary attachment force during bubble nucleation
$F_p$	foam production under sparging
$F_p^*$	foam production under agitation
$G_{ad}$	adsorption energy
$G$	Gibbs coefficient of elasticity
$H_i$	initial foam height
$H_r$	residual foam height
$H_f$	foam height
$H_{equ}$	equilibrium foam height (Bikerman test)
$H_{of}$	immersion depth of orifice tube
$H_{og}$	Oswald coefficient of gas solubility
$h$	thickness of liquid foam film
$h_i$	initial thickness of foam film
$h_t$	final thickness of foam
$h_{tr}$	transitional thickness of foam film
$h_F$	height of foam as defined in test method
$h_s$	height of solution as defined in test method
$h_{st}$	thickness change due to loss of stability
$h_m$	minimum film thickness for bubble coalescence
$h_w$	thickness of aqueous thin film core
$h_{ml}$	thickness of adsorbed monolayer adsorbed on thin film
$h_w$	equivalent thickness of a liquid film
$h_{cr}$	critical thickness of film rupture
$h_{cr,bl}$	critical thickness of film rupture via black spots formation
$J$	diffusion and transfer of soluble surfactant to bubble interface
$J_s$	flow of surfactant along surface of bubble
$K_n$	equilibrium constant for dissociation of mono-species into aggregates
$K$	gas permeability
$K_m$	diffusion coefficient
$K_f$	electro-conductivity of foam
$K_s$	specific conductivity of foam
$K_{dc}$	ratio of foam drainage time to coarsening time ( $t_{dr}/t_c$ )
$k_f$	gas permeability of monoatomic and diatomic atoms
$k_n^o$	dimensionless permeability
$k_o$	coefficient of background permeability
$k_{ml}$	diffusion coefficient of single surfactant monolayer
$k_s$	specific electrical conductivity of bulk solution
$k_f$	electroconductivity of foam

$K_c$	dimensionless number (PB permeability)
$k_{\text{eff}}$	effective coefficient of gas transfer
$L_{\text{pb}}$	Poisson border length (foam structure)
$L$	length of foam train (permeability model)
$l_t$	length of foam film
$l_c$	length of surfactant hydrocarbon chain
$N_f$	number of flips in Hele-Shaw cell
$n$	number of bubbles
$n_f$	intervening films in foam train model (standing diffusion model)
$P$	pressure
$P_l$	liquid pressure
$P_g$	gas pressure
$P_B$	Laplace pressure in Plateau borders
$P_c$	capillary pressure
$P_c^{\text{max}}$	maximum value of the capillary pressure
$P_f$	packing parameter for solid particles at bubble surface
$Q_l$	liquid flow rate
$Q_g$	gas flow rate ( $\text{cm}^3/\text{s}$ )
$R_b$	radius of bubble
$R_{\text{pb}}$	Poisson Boltzman curvature (foam structure)
$R_t$	radius of shrinking bubble
$R_f$	radius of film curvature
$r_b$	radius of bubble or a microscopic film
$r_{\text{equiv}}$	equivalent sphere radius
$r_o$	radius of orifice
$r_f$	film radius
$R_g$	radius of gyration
$S_o$	solubility of gas in liquid
$S_c$	spreading coefficient
$T$	absolute temperature
$T_c$	cycle of period $1/f$
$T_d$	drainage time of thin liquid film between two discs
$T_{\text{TR}}$	Threshold of entry barrier
$t$	time
$t_d$	coalescence time (MTR theory)
$t_s$	thin film stability time
$t_b$	thin film breakage time
$t_{\text{in}}$	thin film inertia time
$t_{\text{att}}$	attachment time (particle and bubble interaction)
$t_i$	induction time (particle and bubble interaction)
$t_r$	thin film rupture time (particle and bubble interaction)
$t_{\text{tpc}}$	three-phase contact time (particle and bubble interaction)
$t_p$	bubble transition or persistence time (coalescence)
$t_{\text{dev}}$	time of deviation (foam test methods)

$t_{tr}$	time of transition (foam test methods)
$t_{1/2}$	half-life of foam (foam test methods)
$t_{dr}$	drainage time
$t_c$	foam coarsening time
$V$	volume of gas
$V_b$	volume of bubble
$V_o$	initial foam volume
$V_i$	initial volume of foam
$\Delta V^F$	change if foam volume (foam test methods)
$\Delta V^S$	change in volume of drained liquid (foam test methods)
$V_h$	volume of hydrocarbon chain
$V_{end}$	final volume of foam produced (surfactant depletion experiments)
$V_d$	foam decay rate
$V_{sgf}$	superficial gas flow rate
$V_L$	liquid drainage velocity
$V_{ab}$	bubble approach velocity
$V_{Re}$	Stefan–Reynolds drainage rate between two discs
$V_{FD}$	forced drainage velocity
$K_p$	bubble persistence constant
$j_g$	superficial gas flow (humidity and evaporation)
$K_H$	Hilgenfeldt ratio of drainage time to coarsening
$v$	liquid flow velocity
$V_{av}$	average approach velocity between two bubbles
$V_{brs}$	bubble rise velocity
$V_{ch}$	bubble approach velocity (Chester Hofman)
$V_k$	bubble approach velocity (Klaseboer)
$V_{y1}, V_{y1}$	bubble approach velocity (Yaminsky)
$V_{cav}$	critical bubble approach velocity
$U$	average rate of foam decay
$U_g$	superficial gas flow rate (m/s)
$U_{term}$	terminal velocity of bubble
$U_{max}$	maximum velocity of bubble
$U_d$	foam decay rate
$W$	work
$W_e$	Weber number
$W_{cr}$	critical value of Weber number
$W$	volume % liquid content of foam (foam test methods)
$W_1$	volume % liquid content of foam (conductivity test methods)
$W_1$	width of liquid inlet channel in microfluidic cell
$W_g$	width of gas inlet channel in microfluidic cell
$x, y$	coordinates in direction to the interface
$z$	coordinate normal to the interface
$\beta$	dynamic contact angle
$\Gamma$	adsorption, surface concentration

$\Gamma_{\infty}$	maximum adsorption, surface concentration
$\Gamma$	surface excess (adsorbed)
$\Gamma_{\text{R}}$	relative adsorption
$\Gamma_{\text{max}}$	maximum amount of coverage of surfactant
$\gamma$	surface or interfacial tension
$\gamma_{\text{o}}$	surface or interfacial tension of a pure solvent system
$\gamma_{\text{dyn}}$	dynamic surface tension
$\gamma_{\text{equ}}$	equilibrium surface tension
$\eta$	dynamic viscosity
$\eta_{\text{d}}$	surface dilational viscosity
$\eta_{\text{sh}}$	surface shear viscosity
$\eta_{\text{d}}$	viscosity of dispersion
$\eta_{\text{o}}$	viscosity of liquid matrix
$l/\kappa$	Debye screening length
$\lambda$	characteristic tube width to bubble radius
$\Pi$	disjoining pressure
$\Pi_{\text{el}}$	electrostatic component of the disjoining pressure
$\Pi_{\text{vw}}$	van der Waals component of the disjoining pressure
$\Pi_{\text{st}}$	steric component of the disjoining pressure
$\Pi_{\text{osc}}$	oscillatory component of the disjoining pressure
$\rho_{\text{l}}$	density of liquid
$\rho_{\text{g}}$	density of gas
$\rho_{\text{R}}$	ratio density (wet and dry foam)
$\Sigma$	Bikermann unit of foaminess
$\tau$	micellar break-up time
$\tau_{1/2}$	lifetime of a foam film or foam
$\theta$	equilibrium contact angle
$\Phi_{\text{l}}$	volume fraction of liquid or wetness of foam
$\Phi_{\text{g}}$	volume fraction of gas fraction
$\Phi_{\text{g,critical}}$	critical gas fraction
$\varphi_{\text{s}}$	volume fraction of dispersed solid
$\chi$	bubble shape deformation factor
$\omega$	angular frequency
$\Psi_{\text{o}}$	surface potential

## Constants

$A_{\text{H}}$	Hamaker constant
$A_{\text{R}}$	retarded Hamaker constant
$F$	Faraday constant
$g$	gravitational constant
$k_{\text{B}}$	Boltzmann constant
$K_{\text{n}}$	dissociation constant

$N_A$	Avogadro number
$R_g$	ideal gas constant
$R_c$	Reynolds number
$T$	absolute temperature

## Abbreviations

BCP	block copolymer
CBF	common black film
CMC	critical micelle concentration
CPP	critical packing parameter
DLVO	Derjaguin, Landau, Verwey, Overbeek theory
FTT	film trapping technique
HLB	hydrophilic/liphophile balance
MTR	Manev–Tsekov–Radoev theory
NBF	Newton black film
POE	polyethylene oxide
RH	relative humidity
WP	Weaire-Phelan (foam cell structure)