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Photopolymerization in dispersed systems

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ABSTRACT

Zero-VOC technologies combining ecological and economic efficiency are destined to occupy a growing place in the polymer economy. Today, Polymerization in dispersed systems and Photopolymerization are the two major key players. The hybrid technology based on photopolymerization in dispersed systems has emerged as the next technological frontier, not only to make processes even more efficient and eco-friendly, but also to expand the range of polymer products and properties. This review summarizes the current knowledge in research relevant to this field in an exhaustive way. Firstly, fundamentals of photoinitiated polymerization in dispersed systems are given to show the favourable context for developing this emerging technology, its specific features as well as the distinctive equipment and materials necessary for its implementation. Secondly, a state-of-the-art and critical review is provided according to the seven main processing methods in dispersed systems: emulsion, microemulsion, miniemulsion, dispersion, precipitation, suspension, and aerosol.

Contents

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Symbols and abbreviations

a	radius of a single particle
AA	acrylic acid
AIBN	azoisobutyronitrile
AMP	azobis-2-methyl–propamidinium dichloride
AOP	advanced oxidation processes
AOT	aerosol-OT, sodium dioctyl sulfosuccinate
APOENPES	ammonium poly(oxyethylene)$_{10}$-p-nonyl phenyl ether sulfate
ARGET	activators regenerated by electron transfer
ATRP	atom transfer radical polymerization
BA	butyl acrylate
BAG	bis(4-methoxybenzoyl)diethylgermanium
BAPO	bis(2,4,6-trimethylbenzoyl)phenylphosphine
BPO	benzoyl peroxide
BuMA	butyl methacrylate
cmc	critical micellar concentration
CTA	chain transfer agent
CTAB	cetyl trimethyl ammonium bromide
DBK	dibenzylketone
DHA	dihydroxyacetone
DMPA	2,2-dimethoxy-2-phenylacetophenone
DPE	1,2-diphenyl-ethane
DTAB	dodecyltrimethyl ammonium bromide
DTBK	di-*tert*-butyl ketone
DS	dodecylsulfonate
DTBA	p-(4-diethylthiocarbamoylsulfanylmethyl) benzoic acid
DVB	divinyl benzene
E_i	activation energy of initiation [kJ mol^{-1}]
$\boldsymbol{E}_\lambda$	extinction coefficient [m^{-1}]
EGDMA	ethylene glycol methacrylate
FTIR	Fourier transform infrared
GPC	gel permeation chromatography
HDTCl	hexadecyltrimethylammonium chloride
HMB	hydroxymethyl butanone
I-PDMS-I	diiodo-poly(dimethylsiloxane) macrophotoinifer-ter
ICAR	initiators for continuous activator regeneration
INISURF	molecule combining the properties of initiator and surfactant
ISC	intersystem crossing
K_λ	absorption coefficient [m^{-1}]
KPS	potassium persulfate
l	optical path length [m]
λ	wavelength [nm]
λ_0	wavelength of the incident radiation [nm]
L_p	photon radiance emitted per unit solid angle in a given direction [photon m^{-2} sr^{-1} s^{-1}]
LED	light-emitting diode
LVREA	local volumetric rate of energy absorption
m	ratio of the refractive index of the particle (n) to that of the surrounding water
μ	chemical potential
MA	methyl acrylate
MDEA	methyldiethanolamine
MMA	methyl methacrylate
N	number density of droplets (or particles) [cm^{-3}]
n	refractive index of the particle
NHC	N-heterocyclic carbene
NIR	near-infrared
Ω	solid angle [steradian]
P_{abs}	volumetric absorbed photon flux [photon m^{-3} s^{-1}]
$P_{abs}(s)$	polychromatic volumetric absorbed photon flux at any point of the irradiated system
$P_{abs,\lambda}(s)$	monochromatic volumetric absorbed photon flux at any point of the irradiated system
$P_0(\lambda, s)$	monochromatic incident photon flux as a function of λ and s
$P_{0,\lambda}$	monochromatic incident photon flux [photon L^{-1} s^{-1}]
$P_{t,\lambda}$	monochromatic transmitted photon flux [photon L^{-1} s^{-1}]