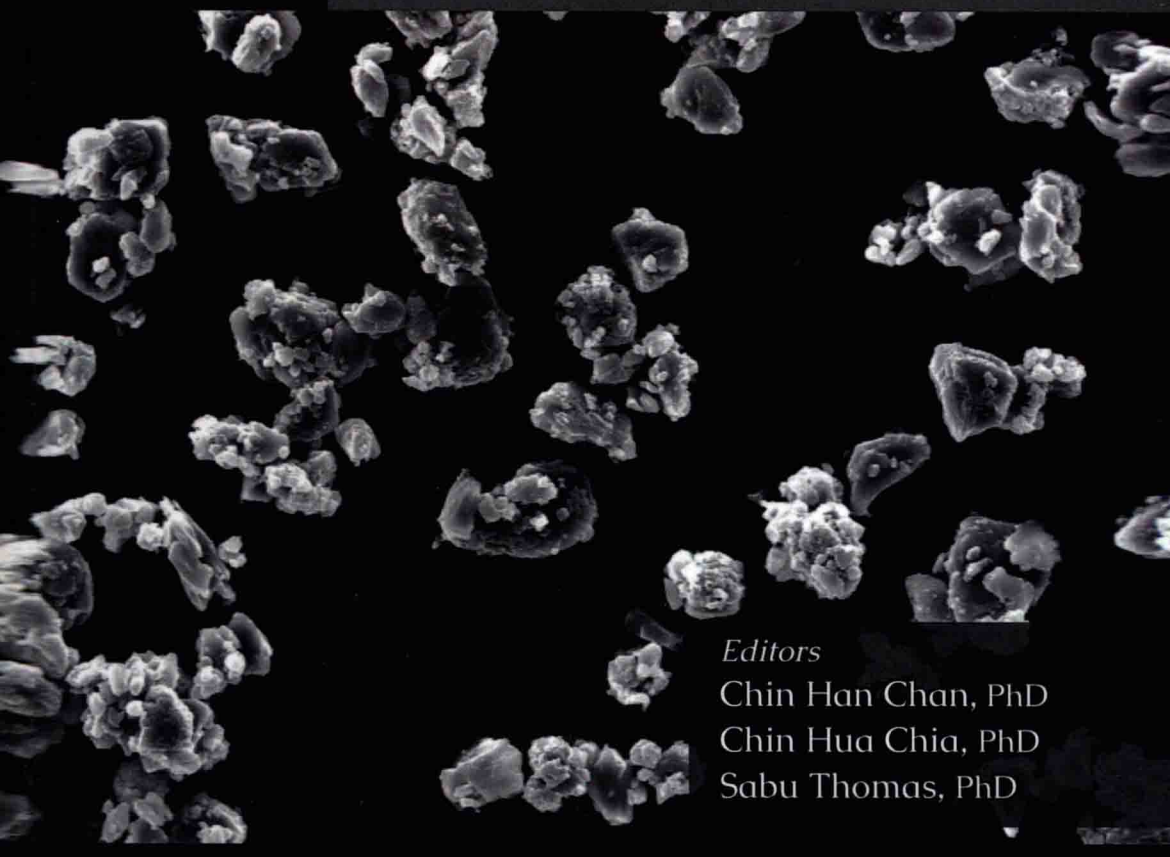
Physical Chemistry of Macromolecules

Macro to Nanoscales



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Chin Han Chan, PhD
Chin Hua Chia, PhD
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PHYSICAL CHEMISTRY OF MACROMOLECULES

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PHYSICAL CHEMISTRY OF MACROMOLECULES

Macro to Nanoscales

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LIST OF ABBREVIATIONS

AA	Acrylic acid
ABS	Acrylonitrile-butadiene-styrene
AC	Alternating current
AFM	Atomic force microscopy
AMIMBr	1-Allyl-3-methylimidazolium bromide
ATHAS	Advanced thermal analysis system
BA	Butyl acrylate
BCF	Bulk continuous fibers
BN	Boron nitride
BR	Butadiene rubber
CAP	Critical adsorption point
CCD	Charge coupled device
CFC	Chlorofluorocarbon
CGF	Chopped glass fiber
CNT	Carbon nanotube
CPE	Constant phase element
CPP	Critical partition point
CR	Chloroprene rubber
CT	Cream time
CTCGs	Content of terminal carboxyl groups
DBTO	Dibutyl tin oxide
DC	Direct current
DE	Degree of esterification
DMA	Dynamic mechanical analysis
DMP	Dimethyl phthalate
DMT	Dimethyl terephthalate
DNA	Deoxyribonucleic acid
DRS	Dielectric relaxation spectroscopy
DSC	Differential Scanning Calorimetry
EBBA	p-ethoxy benzylidene-bis-4-n-butylaniline
EC	Ethylene carbonate
EDM	Electric discharge machining
ENR	Epoxidized natural rubber
EO	Ethylene oxide

EPDM	Ethylene propylene diene monomer
EVAc	Poly(ethylene-co-vinyl acetate)
EVOH	Poly(ethylene-co-vinyl alcohol)
FFB	Fresh fruit bunches
FR	Fire retardant
FTIR	Fourier transform infrared
FWHM	Full width at half maximum
GPC	Gel permeation chromatography
GPE	Gelled polymer electrolytes
HDT	Heat distortion temperature
2HEA	2-Hydroxy ethylacrylate
HFFR	Halogen-free flame retardants
HIP	Hot Isostatic Press
HPLC	High-performance liquid chromatography
IBMA	Isobutyl methacrylate
IDT	Initial decomposition temperature
IR	Isoprene rubber
IS	Impedance Spectroscopy
it-PMMA	isotactic poly(methyl methacrylate)
KWW	Kohlrausch–Williams–Watts
LC	Liquid crystalline
LCP	Liquid crystal polymer
LCST	Lower critical solution temperature
MBBA	4-Methyloxylbenzylidene – 4'-butylaniline
MMA	Methyl methacrylate
MWCNT	Multi-wall carbon nanotube
NBR	Acrylonitrile butadiene rubber
NMR	Nuclear magnetic resonance
NR	Natural rubber
OMMT	Organically modified montmorillonite
OPCs	Organophosphorus compounds
PAN	Poly(acrylonitrile)
PArM	Poly(aryl methacrylate)
PBA	Poly(butyl acrylate)
PBE	Poly(bisphenol A-co-epichlorohydrin)
PBMA	Poly(butyl methacrylate)
PBS	Poly(butadiene-co-styrene)
PBT	Poly(butylene terephthalate)
PBzMA	Poly(benzyl methacrylate)
PCL	Poly(ε-caprolactone)
PCMA	Poly(cyclohexyl methacrylate)
PEA	Poly(ethyl acrylate)

PEAT	Point of exclusion – adsorption transition
PEG	Poly(ethylene glycol)
PEGMA	Poly(ethylene glycol) methacrylate
PEGMe	Poly(ethylene glycol) methyl ether
PEHA	Poly-2-ethylhexyl acrylate
PEO	Poly(ethylene oxide)
PER	Polyester resins
PET	Poly(ethylene terephthalate)
PHAs	Polyhydroxyalkanoates
PHB	Poly(hydroxy butyrate)
PHBV	Poly(hydroxyl butyrate –co– hydroxyl valerate)
PHV	Poly(hydroxyvalerate)
PiBMA	Poly(iso-butyl methacrylate)
PKO	Palm kernel oil
PLA	Polylactide
PMA	Poly(methy acrylate)
PMMA	Poly(methyl methacrylate)
PMVE-Mac	Poly(methyl vinyl ether-maleic acid)
PnBMA	Poly(n-butyl methacrylate)
PNIPAM	Poly(N-isopropylacrylamide)
PO	Propylene oxide
POE	Poly(oxyethylene)
POM	Polarized optical microscopy
PPG	Poly(propylene glycol)
PPhMA	Poly(phenyl methacrylate)
PPMA	Poly(propyl methacrylate)
PPO	Poly(propylene oxide)
PPO-PU	Polypropylene oxide-based polyurethane
PtBMA	Poly(tert-butyl methacrylate)
PTMS	Poly(tetramethylene succinate)
PTT	Poly(trimethyleneterephthlate)
PUNL	Polyurethane-nitrolignin
PVA	Poly(vinyl alcohol)
PVDF	Poly(vinylidene fluoride)
PVME	Poly(vinyl methyl ether)
PVPh	Poly(vinyl phenol)
RC	Resistor-capacitor
RP	Red phosphorus
RPA	Random phase approximation
RT	Rise time
SAN	Poly(styrene-co-acrylonitrile)
SANS	Small angle neutron scattering

SAXS	Small angle X-ray scattering
SBM	Styrene-butadiene-maleic
SBR	Styrene-butadiene rubber
SEC	Size exclusion chromatograms
SEM	Scanning electron microscope
SFG	Short glass fiber
SPE	Solid polymer electrolyte
sPS	Syndiotactic poly(styrene)
TEM	Transmission electron microscope
TEMPO	2,2,6,6-tetramethylpiperidine-1-oxyl radical
TFT	Tack-free-time
TGA	Thermal gravimetrical analysis
TGIC	Temperature gradient interaction chromatography()
TMDSC	Temperature-modulated differential scanning calorimetry
TMPSF	Tetra methyl poly(sulfone)
TR-SAXS	Temperature-resolved small-angle X-ray scattering
UCST	Upper critical solution temperature
UM	University of Malaya
VTF	Vogel-Tamman-Fulcher
WAXS	Wide-angle X-ray diffraction
XRD	X-ray diffraction

PREFACE

The honor of this book shall be credited to Prof. Dr. Hans-Werner Kammer, who served as the Senior Visiting Professor at Universiti Teknologi MARA, Shah Alam, Malaysia (UiTM), from 2008 to 2012. Prof. Dr. Kammer was one of prime driving forces in the initiation of compiling the lectures that are aimed at young reseachers and practitioners. The first part of the book is an elaboration of keynote lectures presented by him and the other authors during the Workshops on Macromolelcules I, II and III (2009, 2010 and 2011). These workshops were organized by UiTM and co-organized by the Malaysian Institute of Chemistry. In this book, Chapters 1 to 12 present a coherent view of a broad number of topics pertaining to basic concepts of polymer science. These chapters comprise polymer characterization, polymer thermodynamics, and the behavior of polymers (melts, solutions, and solids). They emphasize basic science and terms and concepts that are critical to polymer science and technology. These chapters provide a secure ladder for young reseachers and practitioners to progress from the primary level to an advanced level without much difficulty. We note here, physical chemistry of polymer science does require a familiarity with mathematics. However, many of the basic concepts are understandable to researchers who have experienced elementary courses of physical chemistry for tertiary education. The mathematics in these chapters is minimized, and hence, undergraduates and graduates should be able to master the discussion in the chapters.

Nowadays, there is a growing tendency for researchers to attempt to analyze selected phenomena to the greatest depth with increased specialization. The participants of the Workshops on Macromolelcules I, II and III were inspired and have benefited from the keynote lectures, which provided broader perspective at a given domain. The understanding of the basic principles on polymer science resulted in thought-provoking impulses on the experimental design coupled with the results and discussion of research. Some of the participants of the workshops have subsequently presented their valuable research findings at the International Symposium on Advanced Polymeric Materials 2012 (ISAPM 2012). ISAPM 2012 was a joint international symposium on polymeric materials between the

Institute of Materials, Malaysia (IMM), Malaysia, and Mahatma Gandhi University (MGU), Kottayam, Kerala, India, under the auspices of the 8th International Materials Technology Conference and Exhibition (IMTCE 2012) in Kuala Lumpur, Malaysia. The second part of the chapters are the collections of lectures from the ISAPM 2012. Chapters 13 to 19 focus on application areas emphasizing emerging trends and applications of polymeric materials, which cover the advances in the fields of polymer blends, micro- to nanocomposites, and biopolymers.

Finally, we wish to express our sincere gratitude and appreciation to the contributors of the chapters. All criticism, comments, and additional information from reviewers are gratefully appreciated. Special thanks are due to Prof. Dr. Hans-Werner Kammer, the main contributor of the book, who made valuable suggestions for the content of this book. This book is an outcome of the initiative taken by Prof. Dr. Hans-Werner Kammer. We also would like to extend our thanks to Siti Rozana Abdul Karim and Fatin Harun in formatting some of the chapters.

— Chin Han Chan, PhD, Chin Hua Chia, PhD, and Sabu Thomas, PhD

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