## List of Figures

Fig. 1.1	Living polymerization of styrene initiated by naphthalene sodium —— 3					
Fig. 1.2	Initiator and monomer matching in anionic polymerization —— 4					
Fig. 1.3	Schematic diagram of styrene polymerization process initiated by alkali metal —— 8					
Fig. 1.4	Schematic diagram of polymerization process of styrene initiated by sodium naphthalene —— 9					
Fig. 1.5	lon pair and free ion dynamic equilibrium —— 17					
Fig. 1.6	The cyclization reaction end groups of MMA —— 21					
Fig. 1.7	A schematic diagram of two benzo-18-crown ethers-6 —— 23					
Fig. 1.8	Carbonylation and acylation of anionic living chain —— 28					
Fig. 1.9	Schematic illustration of preparation of macromolecular monomers —— 30					
Fig. 1.10	Schematic illustration of synthesis triblock copolymer —— 31					
Fig. 1.11	Schematic diagram of preparation of triblock copolymer by bifunctional initiator —— 32					
Fig. 1.12	Schematic diagram of SBS triblock copolymer prepared by coupling method —— 33					
Fig. 1.12 Fig. 1.13	Schematic diagram of synthesis of four-arm SB star copolymers — 34					
Fig. 1.14	Schematic diagram for the preparation of PMMA-g-PS comb copolymer —— 35					
Fig. 1.15	The relationship between the conversion of monomer and $M_n$ and $M_w/M_n$ in					
116. 1.10	Acove polymerization with $HI/I_2$ as an initiator $36$					
Fig. 1.16	Dynamic equilibrium of multiple active centers in ionic polymerization					
11g. 1.10	system — 37					
Fig. 1.17	Cationic living polymerization of alkyl vinyl ether initiated by the HI/I <sub>2</sub>					
11g. 1.17	system — 37					
Fig. 1.18	Cationic living polymerization of alkyl vinyl ether by EtAlCl <sub>2</sub> /ethyl — 38					
Fig. 1.19	Cationic living polymerization of alkyl vinyl ether by trimethylsilicon compound/					
rig. 1.10	$ZnX_2$ /electron donor — 40					
Fig. 1.20	Living polymerization mechanism of organic tertiary alkyl ester (acid)/BCl <sub>3</sub>					
rig. 1.20	initiation system in haloalkanes —— 41					
Fig. 1.21	The relationship between the degree of polymerization and conversion rate for					
8	living polymerization and apparent living polymerization —— 44					
Fig. 1.22	The [N]–Y curve of apparent living polymerization systems for living					
8	polymerization, zero-order and first-order chain transfer reactions —— 46					
Fig. 1.23	Preparation of terminal functional group polymer by functional group initiator					
8	method —— 48					
Fig. 1.24	Preparation of terminal functional group polymer by end cap method —— 48					
Fig. 1.25	Schematic diagram for DPE used as a capping agent for cationic living					
O	polymerization — 49					
Fig. 1.26	Polymerization of isobutylene initiated by BCl <sub>3</sub> —— 49					
Fig. 1.27	Schematic diagram of preparing a telechelic polymer —— 50					
Fig. 1.28	Schematic diagram of preparing macromolecule monomer —— 51					
Fig. 1.29	Schematic diagram of diblock copolymers prepared by macromolecular initiator					
6	method —— 52					
Fig. 1.30	Schematic diagram of preparation of diblock copolymers by using initiator					
G	activity difference — 52					
Fig. 1.31	Four vanadium compound initiators for living polymerization of propylene —— 54					
Fig. 1.32	Growth reaction of coordination anionic living polymerization of propylene —— 55					
Fig. 1.33	A product of the reaction of diphenylketone with metal potassium — 56					
3	1 2 2 1 2 7 2 2 2 2 2 2 2 2 2 2 2 2 2 2					

Fig. 1.34	
	groups at both ends —— 56
Fig. 1.35	
	with IBC/AgSbF <sub>6</sub> at room temperature —— 57
Fig. 1.30	
	polymerization of tetrahydrofuran initiated with IBC/AgSbF <sub>6</sub> at room
	temperature —— 58
Fig. 1.37	7 Living polymerization of tetrahydrofuran initiated by silver perchlorate and acyl
	halide —— 58
Fig. 2.1	Schematic diagram of the initiation reaction of the group transfer polymerization
	chain —— 63
Fig. 2.2	
Fig. 2.3	Schematic diagram of termination reaction of group transfer polymerization
	chain —— 64
Fig. 2.4	
Fig. 2.5	MTS series initiator —— 67
Fig. 2.6	
Fig. 2.7	
	catalyst —— 72
Fig. 2.8	Aldol–GTP combined with GTP to prepare block copolymer —— 77
Fig. 2.9	Preparation of block copolymer by GPC and atom transfer radical
	polymerization —— 78
Fig. 2.10	Synthesis of telechelic polymer —— 80
Fig. 2.11	Schematic diagram of a1dol-group transfer polymerization process —— 81
Fig. 2.12	
	polymerization —— 81
Fig. 2.13	Aldol-group transfer polymerization initiated by benzyl halide —— 82
Fig. 2.14	4 Methacrylate and acrylate containing special groups which can be polymerized
	by GTP —— 83
Fig. 2.1	
	GTP —— 83
Fig. 3.1	General formula of 1,2-disubstituted tetraphenylethane derivatives —— 95
Fig. 3.2	·
Fig. 3.3	
	DCDPST as transfer termination agent —— 98
Fig. 3.4	
Fig. 3.5	•
	polymerization using DDDCS as the initiation of transfer terminator —— 105
Fig. 3.6	Relationship between relative molecular mass and conversion of St
	photopolymerization using DDDCS as the initiation of transfer terminator —— 105
Fig. 3.7	GPC curve of PS-CCDCM and PVAc-b-PS-b-PVAc block copolymer —— 106
Fig. 3.8	
Fig. 3.9	DSC curve of PVAc-b-PS-b-PVAc block copolymer —— 107
Fig. 3.10	·
Fig. 3.11	•
Fig. 3.12	
Fig. 3.13	
Fig. 3.14	Schematic diagram of the molecular structure of the gradient copolymer —— 130

Fig.	4.1	The inside-out synthesis route —— 143
Fig.	4.2	The outside-in synthesis route —— 144
Fig.	4.3	Reaction possibilities for the formation of tetramers by AB <sub>2</sub> monomers —— 150
Fig.	4.4	Schematic diagram of self-condensation vinyl polymerization to form dimer —— 154
Fig.	4.5	Crystal structure of a willow-like hyperbranched polymer liquid crystal —— 172
Fig.	5.1	Ring-opening disproportionation polymerization of norbornene —— 179
_	5.2	Preparation of triblock copolymer by ring-opening deuteration polymerization of
0		5-acetoxycyclooctene — 181
Fig.	5.3	Carbene or metal alkylene catalyst —— 183
Fig.	5.4	1-Ru-4,4-dichlorophenyl-1,3-butadiene used as a catalyst for ring-opening
		deuteration polymerization —— 184
Fig.	5.5	New carbene-type Ru catalyst —— 185
Fig.	5.6	Schematic diagram of norbornene living polymerization —— 188
Fig.	5.7	Ring-opening deuteration polymerization of norbornene with $Ru\text{Cl}_3$ as
		catalyst —— 189
Fig.	5.8	Schematic diagram of ring-opening disproportionation polymerization of two
	<b>.</b> .	dicyclopentadiene isomers — 189
_	5.9	Bicyclopentadiene ring-opening polymerization with ReCl <sub>5</sub> as catalyst —— 190
rig.	5.10	Ring-opening deuteration polymerization of polyfluorinated norbornene derivatives $$ 190
Fig	5.11	Ring-opening deuteration polymerization of boron-containing norbornene
rig.	J.11	derivatives [11] —— 191
Fig.	5.12	Ring-opening deuteration polymerization of acetoxynorbornene —— 191
	5.13	Schematic diagram of the synthesis of norbornene random copolymer —— 192
_	5.14	Synthesis of norbornene-dicyclopentadiene-norbornene triblock copolymer —— 193
Fig.	5.15	Schematic diagram of the synthesis of norbornene star polymer — 193
Fig.	5.16	Intent of polymerization of cross-linked polydicyclopentadiene —— 194
Fig.	5.17	Synthesis of polyether ketone-polynorbornene graft copolymer —— 195
Fig.	5.18	Schematic diagram of preparing graft copolymer by deuteration reaction of
		unsaturated pendant polymer with cycloolefin —— 196
Fig.	5.19	Constant ratio ring-opening deuteration polymerization of dicyclopentadiene and
		2-acetoxy-5-norbornene —— 196
Fig.	5.20	Schematic diagram of isotactic cis-polymer synthesis —— 198
Fig.	5.21	Schematic diagram of syndiotactic all-trans polymer synthesis —— 199
Fig.	5.22	Schematic diagram of preparation of block copolymer by active ring-opening
		deuteration polymerization and reactive group transfer polymerization —— 200
Fig.	5.23	Schematic diagram of preparation of triblock copolymer by coupling reaction of
		active ring-opening deuterated polymer —— 200
Fig.	5.24	Schematic diagram of preparation of block copolymer by active ring-opening
		deuteration polymerization combined with atom transfer radical
	- 0-	polymerization — 201
_	5.25	Schematic diagram of the synthesis of comb polymer —— 203
rig.	5.26	Schematic diagram of the synthesis of a comb polymer with a carbon–carbon
F2	r 07	bond attached to the polymer backbone —— 204
rıg.	5.27	Schematic diagram of the synthesis of a star-shaped polymer with functional
Fic	5.28	groups — 204 Schematic diagram of preparation of telepholic polymer by open loop
rıg.	J.20	Schematic diagram of preparation of telechelic polymer by open-loop disproportionation polymerization —— 205
		an appropriate $\alpha$ and $\alpha$ and $\alpha$ are the $\alpha$ are th

Fig. 5	5.29	Schematic diagram of preparation for polyacetylene by ring-opening polymerization —— 205
Fig. 5	5.30	Schematic diagram of an improved method for preparing polyacetylene by
		ring-opening deuteration polymerization —— 206
Fig. 5	5.31	Schematic diagram of preparing polyacetylene using pot benzene as monomer —— 206
Fig. 5	5.32	Schematic diagram of polyacetylene prepared by ring-opening deuteration polymerization of cyclooctate —— 207
Fig. 5	5.33	Schematic diagram of preparation of ion exchange resin by active ring-opening disproportionation polymerization —— 208
Fig. 5	5.34	Preparation of trans-polynorbornene —— 208
Fig. 5		Preparation of trans-polycyclooctene —— 208
Fig. 5		Preparation of polycyclopentene — 209
Fig. 6		1,3-Dipolar cycloaddition reaction diagram. Synthesis of poly-5-
rig. (	J.1	vinyltetrazole —— 217
Fig. 6	3.2	Schematic diagram of epoxide ring-opening reaction of amine attack —— 218
Fig. 6	3.3	Selective ring-opening reaction of dioxirane and benzylamine —— 218
Fig. 6		Schematic diagram of aldol reaction —— 219
Fig. 6		Schematic diagram of preparation of sodium alginate hydrogel by click
0		chemistry — 221
Fig. 6	3.6	Schematic diagram of preparation of cyclic PMMA by ATRP combined with click
Ü		chemistry — 222
Fig. 6	3.7	Schematic diagram of the preparation of dendritic star polymers by ATRP
Ü		combined with click chemistry —— 223
Fig. 6	8.8	Schematic diagram of preparation of diblock copolymer PS-b-PVBTM by RAFT
		combined with click chemistry —— 224
Fig. 6	3.9	Schematic diagram of the synthesis of hyperbranched
		poly(1,2,3-triazole-1,3,5-triazine) (HBP TT) —— 224
Fig. 6	3.10	Schematic diagram of preparation of comb-type sugar-containing polymer—
		polypeptide bioconjugate by RAFT combined with click chemistry —— 225
Fig. 6	3.11	Schematic diagram of preparation of sugar-containing polymer-polypeptide
		bioconjugate by RAFT combined with thiol-dithio exchange reaction —— 226
Fig. 6	3.12	Reaction process and conditions of PEG modified by Huisgen cycloaddition
		reaction — 227
Fig. 6	3.13	Dispersion of PEG-modified SWNTs with different molecular weights in water —— 227
Fig. 6	3.14	Preparation of 5-phenyltetrazolium salt —— 230
Fig. 6	3.15	Synthesis of triazole glycidyl ether series polymer —— 230
Fig. 6	3.16	Synthesis of poly-5-vinyltetrazole —— 231
Fig. 7	7.1	Schematic diagram of self-assembly of block copolymer —— 238
Fig. 7	7.2	Schematic diagram of self-assembled monolayer film structure — 239
Fig. 7		Schematic diagram of preparation of alternately deposited self-assembled films
Ü		using glass sheets and beakers — 239
Fig. 7	7.4	Different assembly forms of surfactants at different concentrations —— 240
Fig. 7		Relationship between small molecule surfactants and amphiphilic block
0	-	copolymers — 240
Fig. 7	7.6	Schematic diagram of two-phase structure in polystyrene/polybutadiene block
-0.		copolymer —— 240
Fig. 7	7.7	Phase diagram of copolymer PS <sub>310</sub> -b-PAA <sub>52</sub> dioxane/water-mixed solution —— 242
-0.		2.2.2.2.0

Fig. 7.8	Effect of salt concentration on the morphology of the $PS_{410}$ -b-PAA $_{25}$ system self-assembly —— $244$
Fig. 7.9	Schematic diagram of hydrogen-bonded graft copolymer self-assembly —— 248
Fig. 7.10	Effect of MCPS molar mass on micellar size — 248
Fig. 7.11	Formation of Au/PLys hollow microcapsule —— 252
Fig. 7.12	Schematic diagram of the process of PI and P4VP self-assembly into hollow
8~	spheres (a), the self-assembling and structural fixation process of cross-linkable PAE and P4VP (b) —— 253
Fig. 7.13	Schematic diagram of the formation of a "six-ring" dendritic self-assembled
1.6	structure by hydrogen bonding —— 255
Fig. 7.14	Schematic diagram of dendritic self-assembly structure by metal-ligand
	chelation —— 255
Fig. 7.15	Self-assembly of dendrimers based on electrostatic interaction —— 256
Fig. 7.16	Schematic diagram of the molecular structure and hierarchical self-assembly
Ü	process of HBPO-star-PDMAEMA —— 258
Fig. 7.17	Real-time hierarchical self-assembly process of LCV —— 259
Fig. 7.18	Schematic diagram of preparation of H20-star-PAA —— 260
Fig. 7.19	Effect of pH on the morphology of H20-star-PAA single molecule micelles —— 261
Fig. 7.20	Schematic diagram of phase transition of H2O-star-PAA in concentrated
	solution —— 261
Fig. 8.1	The structure of C <sub>60</sub> diagram —— 267
Fig. 8.2	Fullerene when n is large —— 267
Fig. 8.3	The structure of single-walled nanotubes (left) and multi-walled carbon
	nanotubes (right) —— 268
Fig. 8.4	The phase diagram of carbon allotropes —— 269
Fig. 8.5	The structure of graphene —— 270
Fig. 8.6	Transition between carbon nanomaterials —— 270
Fig. 8.7	Vector illustration of atoms arranged on carbon nanotubes —— 282
Fig. 8.8	Schematic diagram of the structure C <sub>60</sub> -containing macromolecular
	derivatives —— 286
Fig. 8.9	Various "on-chain"-type C <sub>60</sub> polystyrene derivatives prepared by
	p-chloromethylstyrene as a monomer —— 292
Fig. 8.9	(continued) —— 293
Fig. 8.10	Dendritic C <sub>60</sub> macromolecular derivatives. (a) Side group suspension type;
	(b) side chain suspension type; (c) star type; and (d) tree type —— 294