

論文 / 著書情報
Article / Book Information

題目(和文)	
Title(English)	Studies on Directed Self-Assembly of Diblock Copolymers Using Electron-Beam Resist Patterns as Alignment Guides
著者(和文)	山口徹
Author(English)	Toru Yamaguchi
出典(和文)	学位:博士(工学), 学位授与機関:東京工業大学, 報告番号:乙第4138号, 授与年月日:2017年3月31日, 学位の種別:論文博士, 審査員:彌田 智一,中嶋 健,穴戸 厚,長井 圭治,早川 晃鏡
Citation(English)	Degree:Doctor (Engineering), Conferring organization: Tokyo Institute of Technology, Report number:乙第4138号, Conferred date:2017/3/31, Degree Type:Thesis doctor, Examiner:,,,,,
学位種別(和文)	博士論文
Category(English)	Doctoral Thesis
種別(和文)	要約
Type(English)	Outline

Contents

Abstract	i
Acknowledgements	iii
Contents	v
List of Figures	vii
1 General Introduction	1
1.1 Issue to Tackle in This Thesis	1
1.2 Current Status of Directed Self-Assembly of Block Copolymers	5
1.2.1 Microphase Separation of Block Copolymer	5
1.2.2 Block Copolymer Lithography	6
1.2.3 Directed Self-Assembly of Block Copolymers	8
1.3 Objectives of this study	15
2 Neutralization Layer for Randomly-Aligned Vertical Lamellae Formation	19
2.1 Introduction	19
2.2 Experimental	21
2.3 Generation Mechanism of Line Edge Roughness	21
2.3.1 Line edge roughness of resist patterns	21
2.3.2 Polymer aggregates	22
2.4 Strategy of Roughness Reduction	23
2.5 Cross-Linked Positive-Tone Resists	25
2.5.1 Cross-Linking System	25
2.5.2 Roughness Evaluation	29
2.6 Binary-Solvent Developer for Cross-linked Positive-tone resists	32
2.7 Effect of binary solvent on resist patterning	32
2.8 Effect of binary solvent on roughness	36
2.9 Application to Vertical Lamellar Formation	38
2.10 Conclusion	40
3 Graphoepitaxy of Vertical-Aligned Microphase Separated Domains of Block Copolymers By Using Resist Patterns as Alignment Guide	43
3.1 Introduction	43
3.2 Conventional Graphoepitaxy Using Micropatterned Substrate	45
3.2.1 Materials and processes	45
3.2.2 Self-Assembly on a flat surface	45
3.2.3 Graphoepitaxy	47

3.3	Novel Approach to Graphoepitaxy	48
3.3.1	Motivation	48
3.3.2	Materials	48
3.3.3	Graphoepitaxy	50
3.4	Roughness Evaluation of Etched Patterns	56
3.5	Conclusion	59
4	Graphoepitaxy of Liquid-Crystalline Block Copolymer For High Resolution and Long-Range Ordering	61
4.1	Advantage of liquid-crystalline diblock copolymer	61
4.2	Self-assembly on a flat surface	62
4.3	Graphoepitaxy	64
4.4	Ordering analysis	68
4.5	Conclusion	71
4.6	Experimental	72
4.6.1	Materials	72
4.6.2	Sample preparation	72
4.6.3	Characterization	72
4.6.4	Image Analysis	73
4.7	Appendix	74
4.7.1	Validity of ordering analysis procedure	74
4.7.2	Impact of missing cylinders on ordering properties	75
4.7.3	Decrease in bond-orientational correlation function	77
5	General Conclusion	99
5.1	Conclusions	99
5.2	Future Outlook	101
	Achievements	103
	Bibliography	113