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Abstract

DLC/a-Si bilayer film was deposited on germanium substrate where a-Si layer was firstly deposited on the substrate using DC magnetron sputtering. DLC layer was then deposited on the a-Si layer using pulsed filtered cathodic arc (PFCA) method. In-situ ellipsometry was used to monitor the thicknesses of the growth films, allowing a precise control over the a-Si and DLC thicknesses. The bilayer films were deposited with different DLC/a-Si thickness ratios, including 2/2, 2/6, 4/4, 6/2 and 9/6. The effect of DLC/a-Si thickness ratios on the sp^3 content of DLC was analyzed by Raman spectroscopy. The results show that a-Si layer has no effect on the structure of DLC film. Furthermore, the upper shift in G-peak position and the decrease in I_D/I_G inform that sp^3 content of the film is directly proportional to DLC thickness. The DLC/a-Si thickness ratio 9/6 was further analyzed using transmission electron microscopy (TEM) and X-ray photoelectron spectroscopic (XPS) depth profile. It was found that carbon atoms implanting on a-Si layer act not only as a carbon source for DLC formation, but also as a source for SiC formation. The Raman peak positions at 796 cm^{-1} and 972 cm^{-1} corresponded to the longitudinal optical (LO) and transverse optical (TO) phonon modes SiC, respectively, the thicknesses of bilayer films were also estimated using spectroscopic ellipsometry (SE).

In this work, DLC/a-Si bilayer film with a thickness ratio of 10/7 nm was deposited simultaneously on three types of substrate: SiO_2, Ge, and Ta_2O_5. The results revealed that the thickness of the growth film strongly depended on the surface energy of the substrate. The lowest thickness of a-Si layer of 5.64 nm was observed on SiO_2 substrate due to the highest substrate surface energy of SiO_2 surface. The a-Si layer thicknesses of 6.30 and 6.97 nm were observed on Ge and Ta_2O_5, respectively. This indicates that Ge and Ta_2O_5 have lower substrate surface energy than that of SiO_2 surface. However, the DLC films deposited on each a-Si layer of three substrates have the same thickness approximately of 9.9 nm, because all of them were deposited on a-Si layer-coated substrates having the same surface energy. This information may be important for analysizing and developing bilayer protective films for future hard disk drive.

Keywords: Amorphous silicon (DLC)/ Diamond-like carbon/
Pulsed filtered cathodic arc (PFCA)/ Silicon carbide (SiC)

หัวข้อวิทยานิพนธ์	การพัฒนาการวัดฟิล์มบางคาร์บอนคล้ายเพชรบนหัวอ่าน-เขียน ในกระบวนการผลิต
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บทคัดย่อ

ฟิล์มสองชั้นซึ่งประกอบด้วยฟิล์มคาร์บอนคล้ายเพชร(DLC) และฟิล์มอะมอฟัสซิลิกอน(a-Si) ถูกเคลือบลงบนแผ่นรองรับเจอมาเนียม(Ge) ฟิล์มอะมอฟัสซิลิกอนถูกเคลือบลงบนแผ่นรองรับก่อนด้วยวิธีดีซีแมกนิตรอนสปัตเตอริง หลังจากนั้นฟิล์มคาร์บอนคล้ายเพชรถูกเคลือบลงบนฟิล์มอะมอฟัสซิลิกอนด้วยวิธีพัลส์ฟิลเตอร์คาทอดิคอาร์ค(FCA) ความหนาของฟิล์มถูกวัดและควบคุมด้วยวิธีอินซิทู-อิลิปโซเมทรี ฟิล์มสองชั้นนี้ถูกเคลือบที่อัตราส่วนความหนา(นาโนเมตร) แตกต่างกันประกอบด้วย 2/2, 2/6, 4/4, 6/2 และ 9/6 ผลกระทบต่อปริมาณพันธะ sp^3 เนื่องจากความแตกต่างของอัตราส่วนฟิล์มสองชั้นนี้ถูกวิเคราะห์ด้วยรามานสเปกโทรสโคปี ผลที่ได้พบว่าฟิล์มอะมอฟัสซิลิกอนไม่มีผลต่อโครงสร้างของฟิล์มคาร์บอนคล้ายเพชร ส่วนค่าตำแหน่งของพีค G (G-peak position) ที่เพิ่มขึ้น และค่าอัตราส่วนความเข้มของพีค D ต่อพีค G (I_D/I_G) ที่ลดลง แสดงว่าปริมาณพันธะ sp^3 แปรผันตรงกับความหนาของฟิล์มคาร์บอนคล้ายเพชร ฟิล์มสองชั้นที่อัตราส่วน 9/6 ถูกนำไปวิเคราะห์ต่อด้วยกล้องจุลทรรศน์อิเล็กตรอนแบบส่องผ่าน(TEM) และเอกซเรย์สเปกโทรสโคปี(XPS) แบบวิธีเด็ปโพรไฟล์(depth profile) พบว่าไม่ใช่มีเพียงแต่การเกิดคาร์บอนในฟิล์มคาร์บอนคล้ายเพชรที่ปลูกบนฟิล์มอะมอฟัสซิลิกอน(a-Si)เท่านั้นแต่ยังพบว่ามีซิลิกอนคาร์ไบด์(SiC) เกิดขึ้นอีกด้วย นอกจากนั้นยังพบรามานพีคที่ 796 cm^{-1} และ 972 cm^{-1} ซึ่งตรงกับ LO (longitudinal optical) และ TO (transverse optical) โฟนอนโหมดของซิลิกอนคาร์ไบด์ตามลำดับ ความหนาของฟิล์มสองชั้นนี้ได้ถูกประมาณค่าโดยวิธีสเปกโทรสโคปิก อิลิปโซเมทรี

ฟิล์มสองชั้นประกอบด้วยฟิล์มคาร์บอนคล้ายเพชรหนา 10 นาโนเมตร และฟิล์มอะมอฟัสซิลิกอนหนา 7 นาโนเมตร ถูกเคลือบลงบนแผ่นรองรับ 3 ชนิดพร้อมกันซึ่งประกอบด้วยซิลิกอนไดออกไซด์

(SiO_2) เจอมาเนียม (Ge) และแทนทาลัมเพนตะออกไซด์ (Ta_2O_5) ผลปรากฏว่าความหนาของฟิล์มที่เคลือบบนผิวรองรับทั้งสามชนิดขึ้นกับพลังงานพื้นผิวของแผ่นรองรับอย่างชัดเจน ความหนาบนแผ่นรองรับซิลิกอนไดออกไซด์ต่ำสุดของฟิล์มอะมอฟัสซิลิกอนมีค่าเท่ากับ 5.64 นาโนเมตร เนื่องมาจากมีพลังงานพื้นผิวสูงสุด ส่วนความหนาของฟิล์มอะมอฟัสซิลิกอนบนแผ่นรองรับเจอมาเนียมและแทนทาลัมเพนตะออกไซด์มีค่าเท่ากับ 6.30 และ 6.97 นาโนเมตร ตามลำดับ ซึ่งเป็นการบ่งชี้ว่าแผ่นรองรับเจอมาเนียมและ แทนทาลัมเพนตะออกไซด์มีพลังงานพื้นผิวต่ำกว่าแผ่นรองรับซิลิกอนไดออกไซด์ อย่างไรก็ตามความหนาของฟิล์มคาร์บอนคล้ายเพชรที่เคลือบบนฟิล์มอะมอฟัสซิลิกอนของแผ่นรองรับทั้ง 3 ชนิด มีค่าใกล้เคียงกันคือ 9.9 นาโนเมตร เนื่องจากว่าฟิล์มคาร์บอนคล้ายเพชรนี้ถูกเคลือบลงบนฟิล์มอะมอฟัสซิลิกอนซึ่งมีค่าพลังงานพื้นผิวที่เหมือนกัน ข้อมูลเหล่านี้อาจจะมีความสำคัญในการวิเคราะห์และพัฒนาฟิล์มสองชั้นที่ใช้เคลือบเพื่อการป้องกันผิวฮาร์ดดิสก์ในอนาคต

คำสำคัญ : คาร์บอนคล้ายเพชร/ ซิลิกอนคาร์ไบด์/ พัลส์ฟิลเตอร์คาทอดิคอาร์ก/ อะมอฟัสซิลิกอน

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CONTENTS

		PAGE
ENGLISH ABSTRACT		i
THAI ABSTRACT		iii
ACKNOWLEDGEMENTS		iv
CONTENTS		v
LIST OF TABLES		viii
LIST OF FIGURES		ix
CHAPTER		
1. INTRODUCTION		
1.1	Motivation	1
1.2	Research Objective	1
1.3	Research Boundarie	2
1.4	Advantage and Application	2
1.5	Slider Fabrication Process	3
1.5.1	Up-Stream Slider Fabrication Process (Front End)	5
1.5.2	Middle-Stream Slider Fabrication Process Clean Room	7
1.5.3	Down-Stream Slider Fabrication Process (Back End)	9
1.6	Problem Statement	12
2. REVIEW AND THEORY		
2.1	Diamond-Like Carbon	13
2.1.1	Introduction	13
2.1.2	Bonding	13
2.1.3	Hybridization	14
2.2	Diamond-Like Character	18
2.3	Deposition Method for DLC	19
2.3.1	Ion Beam Deposition	19
2.3.2	Mass Selected Ion Beam	20
2.3.3	Chemical Vapor Deposition (CVD)	20
2.3.4	Plasma-Enhanced Chemical Vapor Deposition (PECVD)	22
2.3.5	Pulsed Laser Deposition	22
2.3.6	Sputtering	22
2.3.7	Filtered Cathodic Arc	24
2.4	DLC Property	25
2.4.1	Mechanical Property	25
2.4.2	Adhesion	25
2.4.3	Wear	26
2.4.4	Surface Property	28
2.4.5	Optical Property	28
2.5	Application in Hard Disk Drive (HDD)	29
2.6	Characterization	31
2.6.1	Film Thickness	31
2.6.2	Film Structure	31
2.6.3	Chemical Composition	32

2.7	Metrology of DLC Film	32
2.7.1	Thickness Measurement	32
2.7.1.1	Transmission Electron Microscopy (TEM)	32
2.7.1.2	TEM Cross-Section	34
2.7.1.3	Focused Ion Beam Microscopy (FIB)	34
2.7.1.4	Spectroscopic Ellipsometry	35
2.7.2	Surface Morphology	38
2.7.2.1	Atomic Force Microscopy (AFM)	38
2.7.3	Chemical Bonding Structure	39
2.7.3.1	Bonding Structure Characterization	39
2.7.3.2	X-ray Photoelectron Spectroscopy (XPS)	41
2.7.4	Mechanical Property Measurement	43
2.7.4.1	Wear Measurement	43
2.7.4.2	Scratch Measurement	44

3. EXPERIMENTAL METHODOLOGY

3.1	Equipment and Material	46
3.1.1	Optimum Condition for DLC/a-Si Thin Film Coating System	46
3.1.2	Preparing of DLC/a-Si Thin Film Stack Ratio	47
3.1.3	Characterization of DLC/a-Si Thin Film	47
3.2	Pulsed Filtered Cathodic Arc (PFCA) System	47
3.2.1	Continuous Versus Pulsed	47
3.3	Film Preparation	50
3.4	Study of DLC/a-Si Thin Film Property	52
3.4.1	Study of Chemical Bonding of DLC/a-Si Thin Film	52
3.4.2	Study of Surface Morphology of DLC/a-Si Thin Film	53
3.4.3	Study of Chemical Composition of DLC/a-Si Thin Film	54
3.4.4	Study of Thickness of DLC/a-Si Thin Films	54
3.4.4.1	TEM Sample Preparation of DLC/a-Si Thin Films	55
3.4.5	Study of Optical Property of DLC/a-Si Thin Films	57

4. RESULTS AND DISCUSSION

4.1	Results on Varying Thickness of DLC/a-Si Thin Film Stack Ratio	58
4.1.1	Thickness and Morphology of Film Stack Layer	58
4.1.2	Film Stack Validation Via Spectroscopic Ellipsometry	62
4.1.2.1	Structure of Sample Evaluation	63
4.1.2.2	Analysis Model	67
4.1.3	Further DLC Bonding Study with Raman Spectroscopy	69
4.2	The Results From Various Wafer Substrate on Germanium, Tantalum and Silicon	72

5. CONCLUSION

5.1	Summary	76
5.2	Future Work	76

REFERENCES **77**

APPENDIX A **85**

APPENDIX B **91**

APPENDIX C **97**

APPENDIX D **103**
APPENDIX E **112**

CURRICULUM VITAE **118**

LIST OF TABLES

TABLE		PAGE
2.1	Typical properties of amorphous carbon, diamond, graphite, C_{60} and polyethylene	17
2.2	Comparison of wear rate for ta-C and a-C:H	27
3.1	DLC and a-Si films thickness for each stack	51
4.1	In-situ ellipsometer monitored thickness value and TEM total thickness	60
4.2	Summary of bi-layer DLC/a-Si thin film stack ratio and surface roughness (Ra)	61
4.3	XPS binding energy of different bonds	65
4.4	The thickness of each layer of all the bi-layer DLC/a-Si film stacks and MSE from SE model #3 calculation	68
4.5	In-situ monitoring thickness and TEM total thickness	68
4.6	Raman information extracted from Raman spectra	70
4.7	Contact angles of water droplet (1µL) and root mean square (RMS) roughness of the bare substrates. The average contact angle from each substrate was measured from 5 different positions on the substrate surface at room temperature	72
4.8	Average thickness of a-Si layer, DLC film and root mean square (RMS) roughness of DLC film on different substrates. The thickness of a-Si and DLC films were averaged from 10 positions in TEM image	74

LIST OF FIGURES

FIGURE		PAGE
1.1	Hard disk drive component and magnetic recording heads	3
1.2	Slider fabrication process	4
1.3	Wafer of 6 inch diameter	5
1.4	Wafer slicing	5
1.5	Fixture for holding bar and connecting bar with printed circuit board	5
1.6	Lapping process for open read/write element	6
1.7	Pole geometry measurement	6
1.8	Relief cut on bars	6
1.9	Fine lapping process	7
1.10	Coating of DLC film on slider	7
1.11	Three-inch pallet (Tip) preparation	8
1.12	Patterning on surface	8
1.13	Coating of DLC pas on slider	8
1.14	Slider's etching	9
1.15	Tip de-bond to bars	10
1.16	Dicing bars into individual slider	10
1.17	Slider de-bond	10
1.18	Robot sort	11
1.19	Quasi static test	11
1.20	Slider inspections using microscope	11
1.21	Schematic of read/write head, magnetic spacing and flying height	12
2.1	sp^3, sp^2 and sp^1 configuration	13
2.2	Shape of 1s and 2p orbitals	13
2.3	Sigma bond created from two s atomic orbitals	14
2.4	Two p-orbitals in the first diagram overlap to create pi bonds	14
2.5	sp^3 hybridization mechanism	15
2.6	sp^3 configurations	15
2.7	sp^2 hybridization mechanism	16
2.8	sp^2 configuration	16
2.9	sp hybridization mechanism	16
2.10	sp^1 configuration	17
2.11	Ternary diagram, sp^2, sp^3 and H-Content of ta-C, ta-C: H, a-C:H and a-C	18
2.12	Comparison of calculated C-C sp^3 fraction of ta-C, with experimental data of Fallon et al.	19
2.13	Schematic of RF ICP ion beam source	20
2.14	Schematic diagram of RF-ICPECVD	21
2.15	Schematic of ECR-CVD system	21
2.16	Schematic of PECVD system	22
2.17	DC magnetron sputtering system	23
2.18	Ion beam assisted deposition system	23
2.19	Simplified schematic of basic cathodic arc configuration	24
2.20	Simplified schematic of basic magnetic filtered configuration	25
2.21	Hard disk architecture	29
2.22	Cross-section of head and disk interface	30
2.23	Variation of carbon thickness on disk and slider, magnetic spacing and fly height with storage density	30

LIST OF FIGURES (cont.)

FIGURE		PAGE
2.24	Two modes of TEM operation. (a) imaging modes. (b) analytical mode	33
2.25	A TEM cross-sectional view of a nano-field-effect transistor thinned by conventional methods (not FIB)	34
2.26	Principle of FIB	35
2.27	Basic configuration for reflection ellipsometry	36
2.28	Flowchart for analysis procedure	36
2.29	Block diagram of atomic force microscope	38
2.30	514 nm Raman spectrum of highly orientated graphite	39
2.31	Showing raw Raman spectra and fitted spectra of DLC	40
2.32	Raman spectra was fitted into two peaks of DLC	40
2.33	Raman spectra with various excitation wavelengths for ta-C	41
2.34	Block diagram of X-ray photoelectron spectroscopy	42
2.35	Ar^+ ion sputtering of the outer surface	42
2.36	XPS depth profile	43
2.37	Worn out region at load 40 µN with scanning of 2 passes	44
2.38	Worn out region average depth	44
2.39	Residual impressions from a scratch test in a 1 um DLC film using ramped force up to 50µN	45
2.40	Plot showing drop in lateral force during scratch measurement indicating film failure at 38µN load	45
3.1	Pulsed filtered cathodic arc (PFCA) system Veeco company Inc, model, Nexus DLC-X (a), schematic diagram of PFCA system (b)	48
3.2	PFCA chamber and cathodic arc source (a-b), schematic diagram of PFCA chamber and cathodic arc source (c)	49
3.3	Showing the layers of a-Si and DLC on Ge substrate	50
3.4	Layout of the samples locked inside the PFCA chamber	51
3.5	Schematic of a virtual interface model	52
3.6	Renishaw inVia Reflex Raman spectrometer using visible 514 nm wavelength from argon ion laser (a) Raman and display part (b)	53
3.7	Atomic force microscope (AFM) in a tapping mode, Digital Instruments Veeco, Dimension 5000 (a) AFM and display part (b)	53
3.8	X-ray photoelectron spectroscopic (PHI Quantera SXM)	54
3.9	Transmission electron microscopy (TEM) working at 200 kV, FEI, Tenai^{TM} G^2 20	54
3.10	Focus ion beam(FEI, Strata^{TM} 400 Dual Beam^{TM}) working at 2-30 kV	55
3.11	Showing (a) Pt strip, (b) In-situ lift-out of a specimen by means of a nanomanipulator and (c) SEM image of thinned specimen	56
3.12	Schematic of ellipsometry technique and ellipsometer system	57
3.13	Schematic representation of the double-layer physical models for SE- modeling procedure	57

LIST OF FIGURES (cont.)

FIGURE		PAGE
4.1	Magnified TEM image of bi-layer DLC/a-Si film	58
4.2	TEM images of bi-layer DLC/a-Si for all films stack	58
4.3	Comparison of the thickness as monitored by *in-situ* ellipsometer and TEM	60
4.4	(a) DLC/a-Si 2/2 nm scale bar 7 nm, magnification 300,000 (b) DLC/a-Si 9/6 nm scale bar 7 nm, magnification 300,000	61
4.5	(a)-(f) Surface roughness of DLC/a-Si films deposited at different DLC/a-Si ratios on Ge substrate	62
4.6	Cross-sectional TEM image (×1,000,000) of the films (a) and cropped image from (a) with a brightness and contrast adjustment to provide a clear vision on the cross-sectional morphology of the films (b)	63
4.7	Raman spectra of DLC/a-Si film with a thickness of 9/6 nm	64
4.8	The gross XPS chemical depth profile of DLC/a-Si film with a thickness of 9/6 nm on Ge substrate	65
4.9	The details XPS depth profile of DLC/a-Si film with a thickness of 9/6 nm on Ge substrate	66
4.10	DLC sample structure and fitting model used in this research	67
4.11	Illustration of generated and experimental data of model # 3 for the sample DLC/a-Si film stack 9/6 nm : (a) fitting on psi, (b) fitting on delta at incident angle 75.5°	67
4.12	Comparison of the thickness as monitored by *in-situ* ellipsometer and SE total thickness	69
4.13	Variation of intensity G and A_D+A_G with DLC thickness of film stack.	70
4.14	Variation of G position (a) and I_D/I_G (b) with DLC thickness of film stack	71
4.15	Contact angle of water droplet(1μL) on different substrates: (a) SiO_2 (53^o), (b) Ge (63^o) and (c) Ta_2O_5 (75^o). Schematics in (d) and (e) show that a-Si may form a droplet-like cluster on the substrate of different surface energies. Surface energy affects the shape and height of droplets	73
4.16	Surface morphology of bare substrates: (a) SiO_2, (b) Ge and (c) Ta_2O_5.	73
4.17	Cross-section bright-field TEM images of a-Si and DLC films deposited on different substrates: (a) SiO_2, (b) Ge and (c) Ta_2O_5. Note that the thickness of SiO_2 layer is only 2 nm due to the growth of native oxide on Si substrate	75
4.18	Surface topography of DLC film on different substrates: (a) SiO_2, (b) Ge, and (c) Ta_2O_5. The data were obtained from AFM measurements	75