# 論文 / 著書情報
# Article / Book Information

| | |
|---|---|
| 題目(和文) | |
| Title(English) | Deposition and Characterization of  Non-uniform Structure Adamant Films |
| 著者(和文) | KamisShahira Liza |
| Author(English) | Shahira Liza Binti Kamis |
| 出典(和文) | 学位:博士（工学）,<br>学位授与機関:東京工業大学,<br>報告番号:甲第9968号,<br>授与年月日:2015年9月25日,<br>学位の種別:課程博士,<br>審査員:大竹　尚登,野崎　智洋,平田　敦,因幡　和晃,赤坂　大樹 |
| Citation(English) | Degree:,<br>Conferring organization: Tokyo Institute of Technology,<br>Report number:甲第9968号,<br>Conferred date:2015/9/25,<br>Degree Type:Course doctor,<br>Examiner:,,,, |
| 学位種別(和文) | 博士論文 |
| Category(English) | Doctoral Thesis |
| 種別(和文) | 論文要旨 |
| Type(English) | Summary |

（博士課程）
Doctoral Program

# 論 文 要 旨

THESIS SUMMARY

| | | | | | |
|---|---|---|---|---|---|
| 専攻：<br>Department of | Mechanical Sciences and Engineering | 専攻 | 申請学位（専攻分野）：<br>Academic Degree Requested | 博士<br>Doctor of | (Engineering) |
| 学生氏名：<br>Student's Name | Shahira Liza Binti Kamis | | 指導教員（主）：<br>Academic Advisor(main) | | Naoto Ohtake |
| | | | 指導教員（副）：<br>Academic Advisor(sub) | | - |

要旨（英文800語程度）
Thesis Summary （approx.800 English Words ）


Adamant film is one of the promising surfaces protective coating can be applied in various engineering fields. This dissertation will focus on the adamant film, which consists of boron, carbon and hydrogen elements. The main objective of this study is to improve the mechanical, tribological and biocompatibility of adamant films by surface design and boron incorporation. This thesis is divided into six chapters; Chapter 1 is an overview of adamant films. Briefly introduced the terminology used in the thesis and related background on non-uniform surface structure of carbons. Non-uniform structure will be introduced on the surface of adamant films with the depth scale of 1 to 600 nm.

In Chapter 2, "Deposition and mechanical characterization of segment-structured hydrogen-free DLC films by filtered cathodic vacuum arc (FCVA) method," has demonstrated the work for obtaining segment structure using metal meshes as masks on hydrogen free DLC film. It was found that segment-structured hydrogen-free DLC films (220 × 220 $\mu m^2$ of segment with 30 μm of groove width) have approximately 25% less internal stress than a continuous film without changing their mechanical properties. The maximum film thicknesses were 500 and 600 nm for silicon and SUS403 substrates, respectively owing to a limitation imposed by high compressive stress. Tribological test results indicate that the segment-structured hydrogen-free DLC films have excellent tribological properties than conventional hydrogen-free DLC films. Overall results indicate the segment-structured hydrogen-free DLC films have the advantages of reduced stress and improved the tribological performance.

In Chapter 3, "Deposition of amorphous boron carbide (*a*-BC:H) films for trimethylboron (TMB)," discussed the characteristic of porous *a*-BC:H film as an alternative for segmented DLC films in application where severe tribological conditions and complex shape exist. Several depositions were done by varying deposition parameter such as pressure and TMB gas flow rate in order to obtain porous film surfaces by pulsed plasma chemical vapor deposition (CVD). Their mechanical and tribological behavior will be compared in order to obtain the optimum condition for the deposition. A local oxidation experiment was carried out in humid condition for 90 h on this film in order to study the pores stability. The results show the optimum condition deposition of *a*-BC:H film was at 5 Pa of gas pressure with 15 $cm^3$/min of TMB gas flow rate. This film with is 0.43 B/C ratio shows the good quality characteristic of film. 0.43 B/C ratio film exhibits lower friction coefficient (0.2) sliding against stainless steel ball, high hardness (8.1 GPa) and Young's modulus (62.2 GPa). From the humidity test done on the porous *a*-BC:H films it is observed that humidity diffusion at the pores will spread through the film thickness, finally reaching the film-substrate interface, and cause film delamination. This delamination can be unpredictable and cause early life failures. In order to prevent this delamination mechanism, DLC film was applied between the *a*-BC:H film and substrates in subsequent experiments in this study.

In Chapter 4, “Characterization of porous amorphous boron carbide (*a*-BC:H) films,” The thermal stability and tribological behavior of nano-porous *a*-BC:H films are studied and compared with those in conventional DLC films. Thermal stability of *a*-BC:H films, with no delamination signs after annealed at 500ºC during 1 hour, is better than that of the DLC films, which completely disappeared under the same conditions. Tribological test results indicate that the *a*-BC:H films, even with lower nanoindentation hardness than the DLC films, show an excellent boundary oil lubricated behavior, with lower friction coefficient and reduce the wear rate of counter materials than those on the DLC film. Results show that porous *a*-BC:H films may be an alternative for segmented DLC films in applications where severe tribological conditions and complex shapes exist, so surface patterning is unfeasible.

In Chapter 5, “Deposition and characterization of amorphous boron incorporated DLC films,” *a*-BC:H films with different boron/carbon (B/C) ratio were fabricated by pulsed plasma CVD. The B/C ratio in the films was varied from 0 to 0.4 by controlling the flow rate of TMB in the reaction gas mixture with $C_2H_2$. The *a*-BC:H film with the low B/C ratio of 0.03 exhibited the highest nanoindentation hardness (10.9 GPa) as well as the lowest friction coefficient ($\mu = 0.1$) and wear rate ($3.2 \times 10^{-7}$ $mm^3/Nm$). The *a*-BC:H films with B/C = 0.03 and 0.4 exhibited high-hydrophilicity surfaces owing to their high wettability and high surface energy. An in vitro platelet adhesion experiment was conducted to clarify the effect of boron on the blood compatibility properties of *a*-BC:H films compared with conventional DLC film. The results showed that 0.03 is the optimum B/C ratio for an anti-thrombogenic surface. The synthesized *a*-BC:H films appear to be promising for the surface modification of blood-contacting devices.

In chapter 6, the summary of conclusion for each chapters and this dissertation was included. The future works for this dissertation are also stated.