탄소계 경질 박막의 연구 및 산업 적용 동향

Trend in Research and Application of Hard Carbon-based Thin Films

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Abstract

Diamond-like carbon (DLC) is a convenient term to indicate the compositions of the various forms of amorphous carbon (a-C), tetrahedral amorphous carbon (ta-C), hydrogenated amorphous carbon and tetrahedral amorphous carbon (a-C:H and ta-C:H). The a-C film with disordered graphitic ordering, such as soot, chars, glassy carbon, and evaporated a-C, is shown in the lower left hand corner. If the fraction of sp3 bonding reaches a high degree, such an a-C is denoted as tetrahedral amorphous carbon (ta-C), in order to distinguish it from sp2 a-C [2]. Two hydrocarbon polymers, that is, polyethylene (CH2)n and polyacetylene (CH)n, define the limits of the triangle in the right hand corner beyond which interconnecting C-C networks do not form, and only strait-chain molecules are formed.

The DLC films, i.e. a-C, ta-C, a-C:H and ta-C:H, have some extreme properties similar to diamond, such as hardness, elastic modulus and chemical inertness. These films are great advantages for many applications.One of the most important applications of the carbon-based films is the coating for magnetic hard disk recording. The second successful application is wear protective and antireflective films for IR windows. The third application is wear protection of bearings and sliding friction parts. The fourth is precision gages for the automotive industry. Recently, exciting ongoing study [1] tries to deposit a carbon-based protective film on engine parts (e.g. engine cylinders and pistons) taking into account not only low friction and wear, but also self lubricating properties. Reduction of the oil consumption is expected. Currently, for an additional application field, the carbon-based films are extensively studied as excellent candidates for biocompatible films on biomedical implants. The carbon-based films consist of carbon, hydrogen and nitrogen, which are biologically harmless as well as the main elements of human body. Some in vitro and limited in vivo studies on the biological effects of carbon-based films have been studied [2 ~ 5].The carbon-based films have great potentials in many fields. However, a few technological issues for carbon-based film are still needed to be studied to improve the applicability. Aisenberg and Chabot [3] firstly prepared an amorphous carbon film on substrates remained at room temperature using a beam of carbon ions produced using argon plasma. Spencer et al. [4] had subsequently developed this field. Many deposition techniques for DLC films have been developed to increase the fraction of sp3 bonding in the films. The a-C films have been prepared by a variety of deposition methods such as ion plating, DC or RF sputtering, RF or DC plasma enhanced chemical vapor deposition (PECVD), electron cyclotron resonance chemical vapor deposition (ECR-CVD), ion implantation, ablation, pulsed laser deposition and cathodic arc deposition, from a variety of carbon target or gaseous sources materials [5]. Sputtering is the most common deposition method for a-C film. Deposited films by these plasma methods, such as plasma enhanced chemical vapor deposition (PECVD) [6], are ranged into the interior of the triangle. Application fields of DLC films investigated from papers. Many papers purposed to apply for tribology due to the carbon-based films of low friction and wear resistance. Figure 1 shows the percentage of DLC research interest for application field. The biggest portion is tribology field. It is occupied 57%. Second, biomedical field hold 14%. Nowadays, biomedical field is took notice in many countries and significantly increased the research papers. DLC films actually applied to many industries in 2005 as shown figure 2. The most applied fields are mold and machinery industries. It took over 50%. The automobile industry is more and more increase application parts. In the near future, automobile industry is expected a big market for DLC coating. Figure

1 Research interests of carbon-based filmsFigure 2 Demand ratio of DLC coating for industry in 2005.

In this presentation, I will introduce a trend of carbon-based coating research and applications.

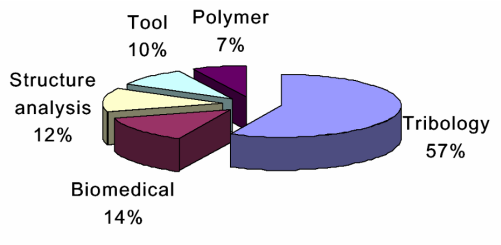

Figure 1 Research interests of carbon-based films

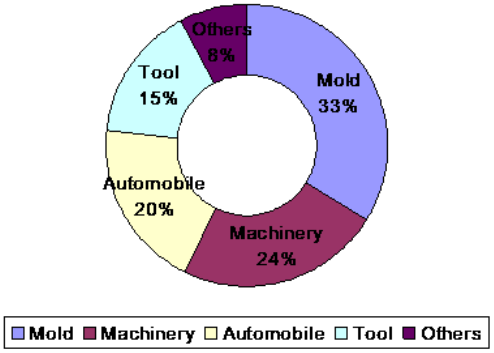

Figure 2 Demand ratio of DLC coating for industry in 2005

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