Development of Various Hard Carbon Films and Their Tribological Properties

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A national project called the “Frontier Carbon Technology (FCT)” project has been in existence in Japan since 1998 with a five-year plan. This project includes Research and Development of hard carbon films with excellent tribological properties such as diamond-like carbon (DLC) films. A DLC film with excellent friction and high wear properties was developed using a plasma-enhanced chemical vapor deposition (CVD) system characterized by a pulse-bias technique. This DLC film exhibited a low friction coefficient of less than 0.05 and a small specific wear rate of $3 \times 10^{-9}$ mm$^3$/Nm, which are superior to the desired targets of the FCT project. Adhesion of a DLC film to its substrate was improved using a process consisting of plasma-enhanced CVD, combined with high-energy ion implantation. The DLC film deposited by this system exhibited good stability under severe sliding conditions, including a 100 N load. A DLC film was synthesized on a complex-shape substrate by a plasma-based ion implantation (PBII) method. The thickness uniformity of the film, deposited on a substrate which simulated a complex shape, was within a distribution of $\pm 10\%$. Moreover, a nanocrystalline diamond film showed good friction and wear properties.

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