EFFECT OF CHEMICAL COMPOSITION OF TRIBOFILM FOR TRIBOLOGICAL PROPERTIES OF SOFT-METAL/DLC NANOCOMPOSITE COATINGS

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ABSTRACT
Diamond-like carbon (DLC) coatings have been widely studied by many researchers as excellent tribo-materials, and the tribological properties such as friction coefficient (FC) and wear resistivity are largely depending on the additives or dopant as well as the nano-structure of the coatings [1]. Adding metals to DLC coatings (Me-DLC) is thus considered as one of the solution to modify the tribological properties under the various loading conditions. We has reported the tribological properties of the Copper/DLC nanocomposite coating (Cu-DLC) and Silver/DLC nanocomposite coating (Ag-DLC) which were prepared using hybrid deposition process composed of plasma enhanced chemical vapor deposition (PECVD) and DC magnetron sputtering of metal target [2, 3].

The tribological properties of both Ag-DLC and Cu-DLC deposited by RF magnetron sputter using composite targets have been presented in this study, as a function of metal concentration in the coatings. Ag-DLC and Cu-DLC were deposited on an Si (100) wafer by commercial RF magnetron sputtering apparatus. Metal/carbon composite target was employed for RF magnetron sputtering process. A Ag or Cu tablet having diameters ranging from 5 to 20 mm was located concentrically on C base target with a diameter of 50 mm. Hereafter, the composite target having this arrangement is termed as "Concentric Composite Target (CCT)". Since metal tablet with high sputter yield is located on the center of C base target where the etching rate is quite low, metal concentration in the Me-DLC becomes low relatively. By changing the diameter of metal tablet, Ag-DLC of Ag concentration from 6 to 50 at.%, and Cu-DLC of Cu concentration from 7 to 75 at.% were prepared. The metal concentration in the coatings was estimated by energy dispersive X-ray spectroscopy (EDS). The thickness of Ag-DLC and Cu-DLC, which were measured by surface-profile measurement between coating surface and substrate, were 0.5 μm and 1.0 μm, respectively. Transmission electron microscopy (TEM) observation showed that the cross-sectional nano-structures of both Ag-DLC and Cu-DLC were granular structure where the nano-crystals of metals were dispersed homogeneously in the coatings, and that the grain size decreased as decrease of the metal content.

The tribological experiments of Ag-/Cu-DLC were performed using linear reciprocating tribometer. A mirror-polished JIS SUJ2 bearing steel ball with a diameter of 6 mm was used as counter materials. The friction coefficient of Ag-DLC with Ag content of 46 at.% showed relatively stable value less than 0.2, but the friction coefficient increased to more than 0.5 as decrease of Ag content to 12 at.%. Furthermore, when Ag content in Ag-DLC decreased to 6 at.%, the FC of Ag-DLC decreased again lower than 0.3. The transition of FC depending on the Ag content in Ag-DLC indicates the correlation to the transition of chemical composition of tribofilm formed on the counterface. The similar result was obtained from the tribo-test of Cu-DLC. These results indicate that the chemical composition of tribofilm plays an important role to control the FC of both Ag-DLC and Cu-DLC. The correlation between FC of Ag-/Cu-DLC and chemical composition of tribofilm on the counterface is discussed.

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