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Effect of graphite domain direction on the friction coefficient of ta-CNx coating

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1. Introduction

The low friction phenomena of carbonaceous coatings are reported its graphitization at the topmost surface by cyclic friction under nitrogen gas [1]. The low friction mechanism of those coatings due to graphitization is divided that low shearing strength graphite sheets were generated at the topmost surface, or graphite domains generated on the topmost surface arranged incommensurate position [2] between transfer layer and its coating. A measurement method capable of detecting the direction of graphite domains formed by friction is interesting. Raman spectroscopy can detect the collective behavior of carbon atom clusters constituting graphite domains [3]. Furthermore, it is assumed that polarized Raman spectroscopy [4], which can control the direction of the incident electric field, can be used to evaluate the direction of graphite domains formed due to friction. In this study, we focus on the existence of such friction induced graphite domains so that we built the direction of the incident electric field can be controlled by rotating the polarizer, and clarify the relationship between the direction of friction and the direction of the graphite domain.

2. Experimental method

A half-wave plate was set among the light source and an optical microscope lends can rotate the polarization of the incident laser beam. The polarizer can rotate 2° of accuracy. The measurement by using the polarizer is divided two types; the incident light polarizer and scattered one is same direction as parallel, and the incident and scattered is perpendicular. Two types of thin coatings were prepared. One was tetra-hedral amorphous carbon nitride (ta-CNx) coating which slid against a Si3N4 ball in vacuum (5.0×10-4 Pa). The other was slid in air under room temperature. The sur-face prepared in vacuum showed approximately 0.013 of friction coefficient, and the surface of in air showed approximately 0.4. The normal load was 0.19 N, sliding speed was 15.7 mm/s under room temperature.

3. Results and discussion

The polarized Raman analysis for low friction coefficient surface (in vacuum) with 10° from 0° as parallel to the friction direction to 90° was conducted as shown in Fig. 1(a) of D peak intensity, and high friction coefficient surface in air; Fig. 1(b). The D peak intensity induced by parallel incident light showed approximately 20 % increase from 0° to 90°. On the other hand, the high friction surface showed approximately 16.8 % increase from 0 to 40°. The D intensity is related to the graphite edge direction [4], therefore, the result indicated that friction induced graphite domains were possi-bly existed on the topmost surface as illustrated in Fig. 1(c) and (d). Since the low friction coefficient is considered to occur by incommensurate configuration, so it is assumed that the transfer layer built on counter material will show different direction of the graphite domain due to frictional force.

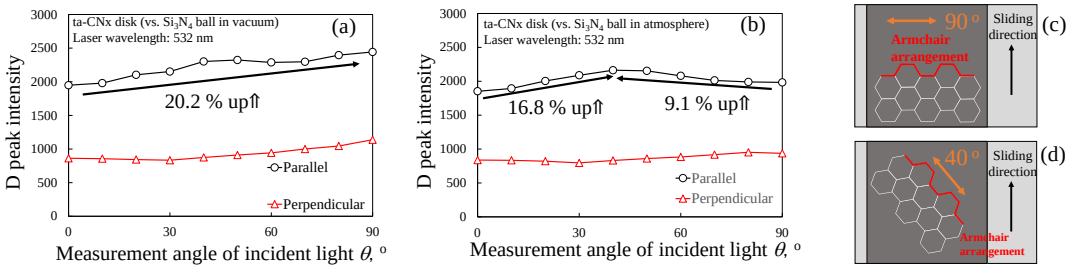

Fig. 1. The D peak intensity as a function of incident light direction (a) low friction in vacuum and (b) high friction in air (c) The D peak intensity as a function of incident light direction of low friction in vacuum and (d) high friction in air.

References

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