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Tribological and temperature stability performance of hydrogen containing amorphous a-C:H:Mo

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Metal containing carbon films (a-C:H:Me) have very good tribological properties especially in reducing the friction coefficient in addition to wear and adhesion reduction. Typical metals for this kind of coatings are tungsten, titanium or chromium. Beside these materials, other metals like molybdenum, also offer a good option for reducing the friction coefficient or wear. The main problem of these films is that at temperatures higher than 30°C the usability is reduced because of degradation of the coatings due to graphitization and oxidation effects.
The a-C:H:Mo films were prepared by reactive d.c. magnetron sputtering in an argon/acetylene atmosphere with two molybdenum targets. The tribological film properties were investigated by nano hardness, pin on disk, wear and scratch tests. To identify the film characteristics at higher temperatures, samples were tempered at normal atmospheric pressure at 150°C to 550°C for 1.5 hours. A polished 1.3343 steel was used as the substrate. The results were compared with the film properties at room temperature. Investigations show that the optimal film properties are at a molybdenum content of 19 at. %. The hardness of that metal content average out at 1240 HV and the wear $2.97x10^{-15}$ mm³/Nm. For the pin on disk tests a normal force of 3 N was used and a distance of 170 m at a rotation of 30 rpm. The a-C:H:Mo coatings exhibits a low friction coefficient of 0,19 under unlubricated conditions and against a steel ball.
The temper tests were executed in 100°C steps and to identify the exact limit, the temperature steps were 25°C. The results show that the hardness is stable up to 350°C, but the wear and the friction coefficient are stable until 375°C.
This study confirms that a-C:H:Mo definitely presents a good option for the application as a friction and wear reduced carbon film and should be suitable for all tribological areas. The temper tests show a temperature stability of at least 350 °C.

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